HYDROGEOLOGICAL STUDY
SOLID WASTE ASPECTS
HAMILTON-WENTWORTH REGION

GARTNER
LEE
ASSOCIATES
LIMITED

Gartner Lee Associates Limited
Consulting Engineering Geologists and Hydrogeologists
460 McNicoll Avenue ▪ Willowdale, Ontario ▪ M2H 2E1 ▪ 416-499-3111

URB/MUN.

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HAMILTON-WENTWORTH REGION

PROJECT NO. 75-66

JANUARY, 1976.

Gartner Lee Associates Limited

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January 23, 1976.

Regional Municipality of Hamilton-Wentworth,
C/o Proctor & Redfern Limited,
20 Hughson Street,
Hamilton, Ontario.

Attention: Mr. R. Tait.

Dear Sirs:

Re: Hydrogeological Study
Solid Waste Aspects
Hamilton-Wentworth Region

We are pleased to submit herewith our hydrogeological report for this regional waste management study. This report is intended to supply supporting data for the overall Proctor & Redfern Limited report (EO 74181).

This report deals with the following aspects:

(1) The regional hydrogeological overview of the Region that supplies a broad reference framework in terms of solid waste opportunities

(2) Results of target area investigations for specific sites

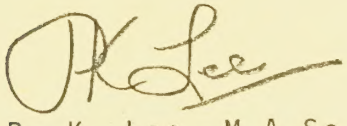
(3) Details of the proposed Glanbrook balefill site

(4) Recommendations for follow-up study if the project proceeds

The data presented are supplemented with drawings and maps, where practical. Other supporting data have been retained on file for future reference.

We trust that this pre-engineering information assists in the overall decision making process. At this time we wish to thank you for this opportunity to be of service in this most interesting project.

Respectfully submitted,
GARTNER LEE ASSOCIATES LIMITED.



P. K. Lee, M.A.Sc., P.Eng.,
Consulting Engineering Geologist.

PKL:sr.
Enclosure.

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CHAPTER 1

1.1 INTRODUCTION

During the Hamilton-Wentworth Region solid waste management study, one of the areas of data input and analysis was that of a hydrogeological nature. Information was supplied at various periods throughout the assignment at a variety of intensities and scales, from the broad regional overview down to evaluations of specific target areas.

The main function then of the present report is to bring these various data together by using the highlights of each stage. In this way back up data is provided for the final Proctor & Redfern Limited report and a proper perspective is provided for the overall study. It should also be remembered that the study is of a planning nature and not intended to provide any information of a design nature.

1.2 SCOPE OF THE STUDY

The scope of the information provided by this report can be subdivided into the following sections:

(a) The regional overview of the existing setting is provided in which the landscape is unitized in terms of the various opportunities and constraints for solid waste disposal

(b) An assessment of specific sites selected for study by the Technical Committee is provided. These sites are mainly gravel pits and quarries and thus can be described as potential eyesores on the landscape. As a result of the findings an emphasis is placed on the possibility for the handling of unacceptable (inert) wastes.

(c) The site specifics for other target areas, primarily the Glanbrook balefill site

(4) Recommendations for further follow up of a hydrogeological nature, if this concept is accepted and proceeds through to Environmental Review Board Hearings.

1.3 BACKGROUND

In 1972 Proctor and Redfern Limited was engaged to carry out a study with respect to the status of solid waste management systems in Wentworth County and the City of Hamilton. This study was extended and was intended to consider an overall solid waste management for the Region for the period of 1975 to 1985.

In 1972 Proctor & Redfern Limited engaged the firm of Terra-Scan Limited to assist them in the study from a hydrogeological-terrain analysis point of view. Their assignment was to provide a regional overview of the terrain that would serve as a reference framework for outlining potential future target areas and assessing the existing sites.

Over a period of time this hydrogeological assessment was combined with other non geotechnical information in order to select target areas for further study. Gartner Lee Associates Limited were retained to assist in this part of the assignment and the work was carried out under the direction of Mr. P. Lee who had completed the earlier regional scale work while employed by Terra-Scan Limited. Several target zones were outlined by the Technical Co-Ordinating Committee and others for study. Public meetings were held subsequently and the data were reassessed in the light of comments received.

This report has thus been prepared to deal with the highlights of each of these phases of input in order to tie these data together to provide a complete picture of the hydrogeological environment and its constraints and opportunities for disposal of solid wastes.

1.4 THE ROLE OF HYDROGEOLOGY

In the disposal of wastes on the land one of the most important factors to be considered is the impact of the facility on the environment and the constraints of the environment on operation of the site. The optimum site is one then of minimal impact and ease of operation.

The safety and suitability of any solid waste disposal facility is dependent mainly on the hydrogeological environment in which it is situated. Therefore, the proper planning and selection of any site requires an understanding of the environment as it now exists and the impact of imposing a waste facility within it in the future. Figure 1 illustrates these and other aspects.

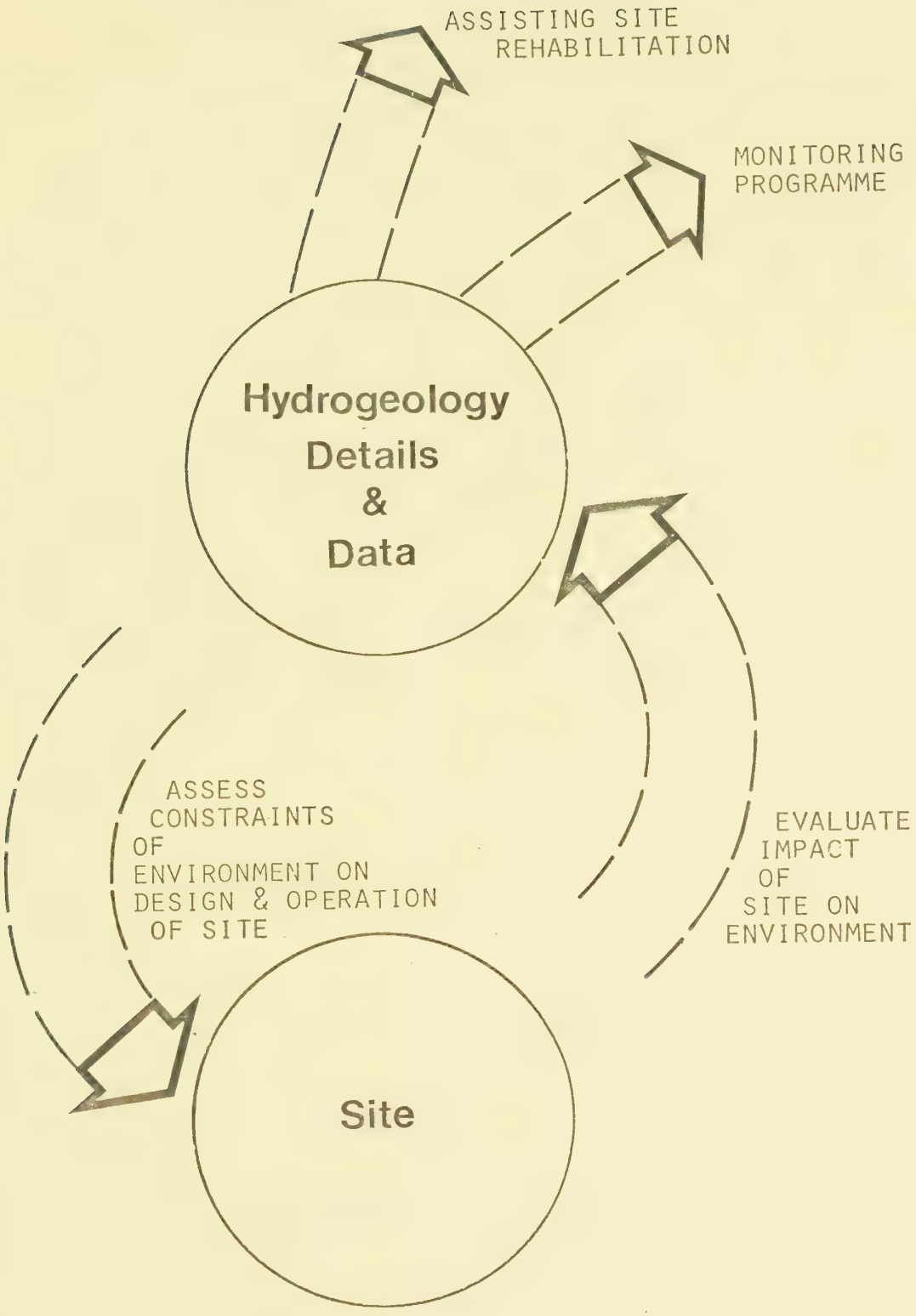

ASSISTING SITE
REHABILITATION
MONITORING
PROGRAMME
Hydrogeology
Details
&
Data
ASSESS
CONSTRAINTS
OF
ENVIRONMENT ON
DESIGN & OPERATION
OF SITE
EVALUATE
IMPACT
OF
SITE ON
ENVIRONMENT
Site

FIGURE 1

CHAPTER 2 - REGIONAL HYDROGEOLOGICAL OVERVIEW

2.1 INTRODUCTION

The site selection process for future landfill facilities should involve the assessment and integration of several factors in order to optimize the delineation of target areas. Conversely the evaluation of existing facilities should be carried out from several points of view. One of the prime considerations is that of a hydrogeological nature.

The broad regional reference framework enables a more logical comparison of the opportunities available and allows a proper relationship between any specific target and its surroundings. In summary, geologic boundaries seldom follow political and/or property boundaries. Therefore, the hydrogeological data assessed in this phase supplies a reference framework for all lands within the total region.

2.2 SCOPE OF THE STUDY

The hydrogeological factors assessed in the Regional overview are listed below:

(a) geological - both soils and bedrock landforms and materials were assessed and included

(i) soils - textures, stratigraphy thickness, permeability, attenuation potential

(ii) bedrock - structure, permeability

(b) groundwater - the flow regime was investigated to outline aquifer relationships, areas of recharge, discharge, hydraulic connection, etc.

(c) surface drainage - areas of floodplain, hazardland, etc.

(d) landforms - ranges of slopes, relief.

Other non geological factors such as planning, land use, agriculture etc. have been considered beyond the scope of the study and these have been applied later by others.

Since this study is of a planning and feasibility nature no primary investigations have been carried out. Therefore no drilling, testing or verification at depth has been attempted.

2.3 METHODOLOGY

The study involved two main parts. The initial part of the work involved the inventory and basic data gathering process. In this regard all of the existing information was gathered, interpreted in terms of landfilling and then plotted onto a common base. Selected references are appended at the end of the main body of the report.

Further surface details were obtained from applying stereoscopic interpretation techniques to 1:40,000 scale photographs. Subsurface interpretations were derived from MOE water well logs. In this way a three dimensional model was built up for the region.

Following the compilation and correlation of the basic data, constraint maps were prepared.

The constraints used in this study are described below

(a) geological

- soils of extreme textures, i.e. very permeable and porous sands and gravels that have minimal attenuation potential
- areas of thin soils over bedrock, usually less than 25'

(b) hydrogeological

- areas of groundwater recharge where precipitation infiltrates downward into an aquifer
- areas of high water table, wetlands
- areas of high hydraulic connection
- areas of hazard land, swamps

(c) landform

- areas of severe slope, erosion, flooding, etc.

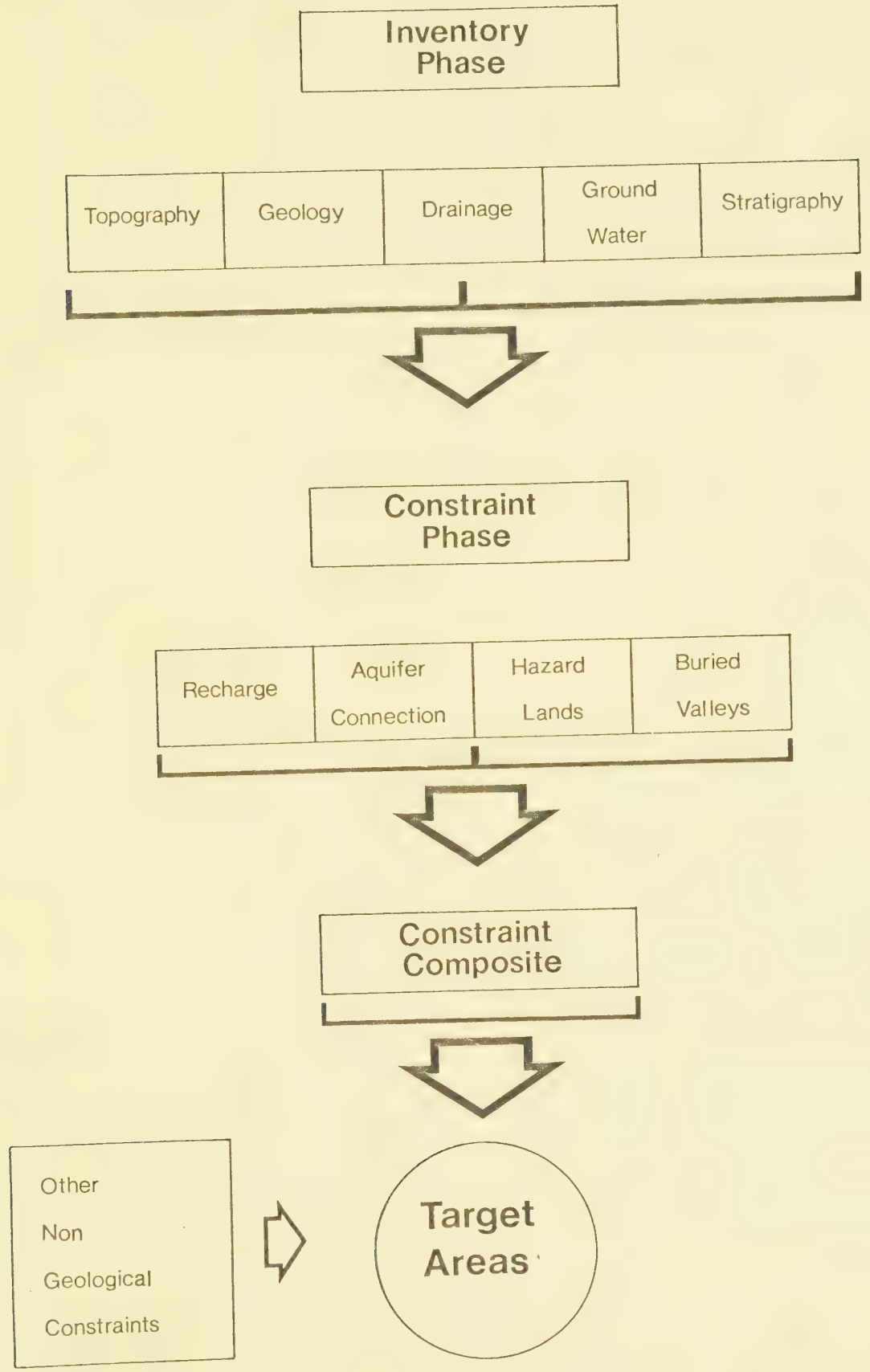

Inventory Phase
Topography
Geology
Drainage
Ground Water
Stratigraphy
Constraint Phase
Recharge
Aquifer Connection
Hazard Lands
Buried Valleys
Constraint Composite
Other Non Geological Constraints
Target Areas

FIGURE 2

Each of the constraint maps were then overlayed to delineate areas of multiple constraints and target zones of minimal problems. These overlay maps and the basic data maps have been placed on file for reference due to the bulk of data. The final composite constraint map (Map 1) summarizes these aspects.

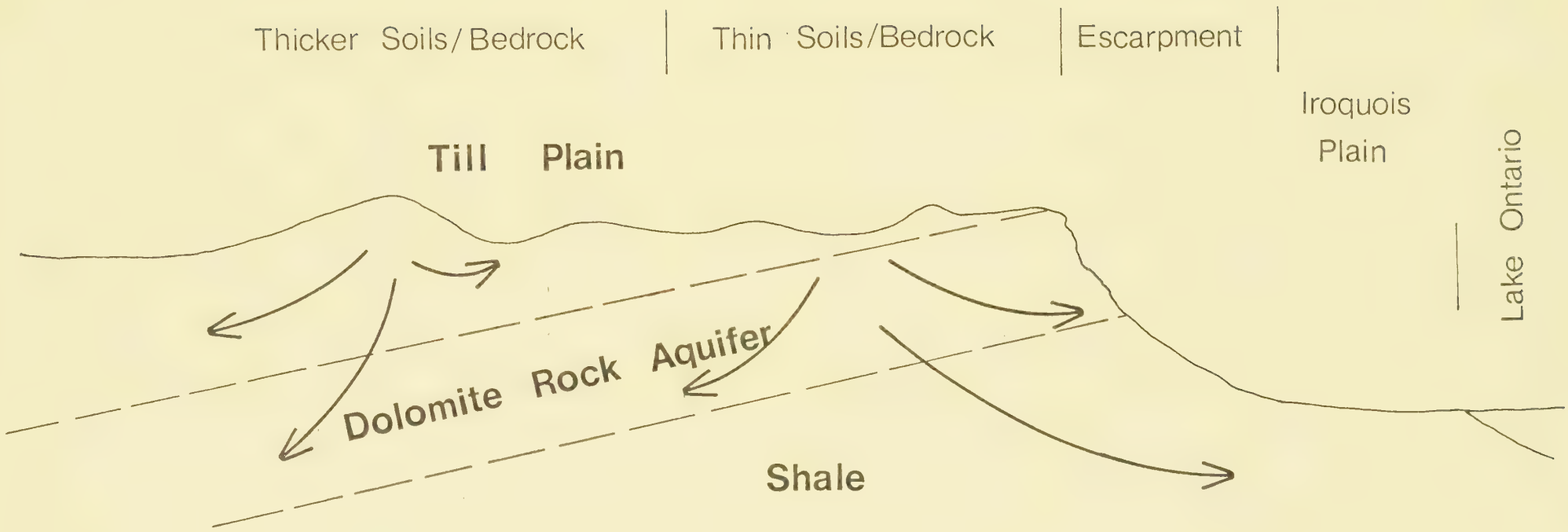
2.4 RESULTS OF THE INVESTIGATION

2.41 GENERAL COMMENTS

The overall setting is illustrated on Map 1 and the units shown are those of landfilling opportunities and constraints. Seven zones have been delineated. Overall even the lands noted most suitable for landfilling do in fact have constaints, mainly those of seasonal workability of the soil and surface drainage.

It is beyond the scope of this report to describe in detail the various subsoil types, the geology, etc. The Region however can be subdivided into broad general environment units as shown on Figure 3, the cross section.

Obviously the Escarpment is the major hydrogeological boundary. The area between the Escarpment and the Lake Ontario shoreline is called the Iroquois plain. The area above the Escarpment is in effect a table land of gently undulating to flat terrain. This table land is divided into northwest and southwest quadrants by a notch cut into the Escarpment, by



Hydrogeological Cross Section
Hamilton-Wentworth Region

FIGURE 3

the Dundas valley. As shown on the cross section the major water well aquifer is the Guelph-Lockport dolomite bedrock. Therefore, in areas where hydraulic connection to the rock is high (porous soils, thin cover etc.) then pollution potential is high. Where zones of recharge occur, that is downward gradients into the aquifer, then the risk of polluting the aquifer is even higher.

The cross section and map show then that large zones within the Region are those of high constraint for landfilling. Most of Flamborough, Stoney Creek, part of Glanbrook and Hamilton fall into this category. More suitable lands then are those of deeper soils with lower permeability and connection, at least from a hydrogeological point of view.

It must be remembered however, that these constraints are only one level of input and analysis and a true picture can only be derived by imposing other constraints upon these.

Details of each of the units shown on the hydrogeological map will now be discussed with respect to the landfilling constraints and opportunities found within each.

2.42 HYDROGEOLOGICAL MAP UNITS

Each of the units that follows are illustrated on the hydrogeological map. The units shown are at a broad scale and thus minor areas may be found within them with local conditions differing from the major unit. Details are as follows.

UNIT 1 - Deep Till Plains

This unit contains lands where fairly deep slowly permeable soils cover the dolomite bedrock aquifer. As shown on the map this unit occupies lands on the south and southwest borders of the Region. Topography is in general flat to gently rolling with local steeper slopes near surface drainage channels. Drainage occurs via flat bottomed river valleys that are confined within fairly distinct river channels. Subsoils here are silty clays and silts of slow permeability. In effect the surface soils are often modified glacial lake sediments that overlie glacial tills at depth and thus create a soil sequence that seals the well aquifer at depth. The pollution potential then for water wells in this unit can be described as minimal.

On the other hand, this environment does have constraints for landfilling. The clayey texture of the soils creates problems of wet weather handling and workability. As well provisions for surface drainage will be necessary and excavation will probably be shallow. These lands are also of excellent agricultural potential.

This unit then has a fairly low pollution potential and constraints will be those imposed on operating procedures.

UNIT 2 - Iroquois Plain

This unit occurs below the Escarpment on the flat fringe between the face of the slope and the lake. This flat plain has a fairly shallow soil cover, however, the rock below is the Queenston shale, itself a very slowly permeable unit, a poor well aquifer. The surface soils are

often a thin layer of sand with red silty clays below. Ground water flows will be towards the lake and generally in a horizontal to slightly discharge (upward gradient) condition. Pollution potential is low except for surface drainage that can be diverted around the operation where necessary. A Burlington site is located within this zone. This unit is also a highly populated area at present.

Although this unit is probably ideal from a workability-pollution potential point of view, other constraints will no doubt eliminate it from consideration.

UNIT 3 - Sands/Deep Clays

This unit borders the edge of the Dundas Valley. Geologically, it represents a zone where glacial lake action deposited stratified sands and silts in an almost deltaic-like environment. It appears from water well logs that clays and tills underlie these sands at depth. A fairly deep soil sequence is thus available.

Precipitation in this environment infiltrates the sands and the water table is created at their base just above the clays. Therefore, this water creates an unconfined aquifer system where the sands are deep enough and local small yield domestic wells can be obtained. The main aquifers are sealed at depth below the clays. Along the margin of this unit the groundwater migrates to shallow troughs where it creates the head of surface drainage.

Landfilling would then take place in the sandy and silty soils above the underlying clays. Both the trenching method and area techniques could probably be employed. Since the sand has little attenuation potential leachate collection drains would probably be needed. The critical factor would be groundwater flow direction and ensuring the safety of shallow wells down gradient. Minimal problems exist for deeper wells.

Local acceptable sites can probably be found within this unit, however, careful analysis and probable remedial safety measures would have to be employed. Pollution problems will be of a shallow and local nature.

UNIT 4 - Silty Sand Tills

This unit is restricted to Flamborough Township and is of limited extent. The subsoils in this unit are silty sand glacial tills. The units have a thickness in general of 25 to 50'± and overlie the dolomite aquifer above the Escarpment. This silty sand till is moderately permeable due to local sand seams and discontinuous lenses. In general, these units are unfortunately also ones of aquifer recharge. It is unfortunate that they are not of a thicker sequence. Local sites may be available within this unit.

UNIT 5 - Dundas Valley

This unit is underlain by an extremely deep soil thickness that has infilled a preglacial notch cut into the Niagara Escarpment. This valley in effect cuts the region into two quadrants. The subsoil sequence is a variable one with the interbedding at depth of clays, tills, sands and gravels. The groundwater at depth is often under artesian head indicating an upward gradient or discharge condition. Surface drainage is erratic and much of the area is occupied by kettle lakes and bogs in its upward limits.

Towards the Town of Dundas glacial stages of Lake Ontario have deposited a sand veneer on the surface that is in turn underlain by clays, etc. Total soil depths are often in the 200'-400' depth.

This unit also may have local zones where landfilling could be possible. Problems are mainly of a surface nature.

UNIT 6 - Shallow Clays Above Escarpment

This unit has shallow clays and silty clays, usually less than 25' deep, that overly the dolomite caprock of the Escarpment. Bedrock over much of the area near the scarp face, in Stoney Creek and Hamilton is often less than 10' below grade. This area then is one of major recharge to the dolomite well aquifer. Minor scarps parallel the main one and surface drainage tends to parallel these before exiting over the Escarpment. The water table is often near grade in these troughs and the local scarps are local recharge zones. Many of the quarries are located on these mini scarps.

This unit represents one of fairly high regional pollution potential. Sites within this unit will require a great deal of engineering and remedial measures along with fairly high risks.

UNIT 7 - Bedrock Plain

This unit occupies most of the Township of Flamborough. Bedrock is always less than 25' and is often on surface. Exceptions to this are the scattered drumlin hills however, these cigar shaped till hills are small and localized. The total area is underlain by the dolomite water well aquifer. Soils within the unit are generally granular and hence fairly highly permeable. These soils are often surface sands that themselves overlie the bedrock. In some

cases these sands lap up onto the silty sand till drumlin highs. Where soils are deeper they coincide with groundwater recharge zones. As well extensive zones of swamp and high water table are present.

This area represents one of poor major landfill possibilities. Local small sites may be possible but even these will require careful analysis and siting.

CHAPTER 3 - TARGET AREA STUDY

3.1 INTRODUCTION

The Technical Co-Ordinating Committee assigned some 21 sites for more intensive terrain study. The purpose of the assignment was to outline the physical setting of each of the sites and assess its suitability for solid waste disposal. This assessment was based on regional scale site requirements. A later assessment was made of these sites as possible sources of deposition of unsuitable solid waste, that is inert materials.

The section that follows summarizes these findings and is basically the data presented in our earlier report 74-27. Due to the bulk of the data the supporting information has been placed in the appendix of the report. The locations of the 21 sites are shown on Map 2.

3.2 METHODOLOGY

This feasibility study was carried out by combining data from a number of sources. Stereoscopic interpretation of 1"=1320' Ministry of Natural Resources airphotos was used to outline surface soils, geology and landforms, drainage etc. Subsurface information was derived from MOE water well records and published geological reports. These evaluations were then examined within the regional reference framework of our

previous study of the Region. A brief field check by an engineering geologist was used to generally confirm the office study and to map further details.

The suitability of each site was then rated with regards to its physical acceptability for placement of solid waste and the potential impact on the physical setting. The factors assessed in this assignment were:

(a) the related geologic landform and soils, possible cover

(b) probable geology at depth

(c) relationship to groundwater and surface water flows

(d) relationship to water wells, aquifers - pollution potential

(e) geotechnical operations

The findings were then discussed with the Committee and a further assessment was made to assess the possibility of using these properties as unacceptable (inert) waste facilities.

3.3 RESULTS OF THE INVESTIGATION

The sites studied can be subdivided into the following categories:

(a)	Sand and Gravel Pits and or Granular lands	- Sites No. 1,2,4,5,6, 11,12,13,14, 15,20 & 21.
(b)	Abandoned Quarries	- Sites Nos. 3,7,8,10, 16,17,18 & 19.
(c)	Other	- Site No. 9.

The findings for each site are contained in an appendix at the end of the report. Maps showing details of ground water flows, rock depths etc. have not been included due to the bulk of data for 21 localities however, these are placed on file and are available for reference for details where and when necessary.

In general, the results of this investigation and the general guidelines of our previous study show that most of these sites selected occupy terrain settings that are probably not suitable for solid waste disposal or landfilling. However, in some cases it may be possible to provide remedial measures with proper engineering and construction to modify the setting. It should be pointed out that such measures will no doubt be costly, will require careful analysis and construction and will require proper operation. Some of the sites should not even be considered for remedial measures due to their high hazard potential. Some sites can be considered for inert waste disposal and these are detailed in section 3.4.

The quarry sites presented several problems and the highlights are as follows. In this area above the Escarpment quarrying has taken place in the Lockport-Amabel dolomite formation. This hard layered rock is also one of the best water well aquifers in Ontario due to its excellent porosity and permeability. Its water transmission ability is excellent, with many wells capable of more than 50 gpm, so that hydraulic connections extend over large distances. Garbage that could produce leachate then that would travel from the site would also be easily and rapidly transmitted. Natural purification in the rock would be almost nil beyond dillution factors. Therefore, in the quarries pollution hazards could be high. Further to this many of the quarries have been sited in areas where the bedrock is topographically high and soils are shallow. Since groundwater tends to follow the rock structure, water tends to mound in such areas and flow outwards and flow down gradient or down slope. These highs in the rock then serve as recharge for those areas of lower elevation. Therefore, most of the quarry sites were in recharge areas with water wells down gradient. Several quarries had been excavated down to and in some cases below the water table so that direct contact with the water flow system was present. Blasting in the quarries had further opened joints in the rock creating excellent channels for water movement and potential garbage leachate pathways, especially where garbage was placed in contact with water in the base of the quarry.

Two quarries where the above situation was slightly different and where further engineering study might be able to design remedial measures were site No. 3, the Sheppard quarry near Clappson's Cut and site No. 17, the Cope quarries. Both of these are presently unsuitable for landfill disposal. However, the quarry near Clappson's Cut is on the brow of the Escarpment where groundwater flow is probably toward the quarry and over the Scarp. Seepage emenating from one part of the face is channelled out and over the scarp as surface flow, in rock ditches. The quarry is fairly well isolated with the nearest down gradient housing ½+ mile to the south. Unfortunately, other minor housing is

situated to the west nearby on the brow of the Escarpment. It may be possible to in effect cocoon the waste in this fairly flat floored hole by placing a clay pad with underdrains, and possibly with other sealing measures. This would require importation of proper fill materials and careful controlled placement. It would be necessary to monitor the groundwater flow with wells to confirm the directions etc. that our preliminary examination anticipates. These wells would also act as a monitoring system for water quality. Leachate will be produced in any landfill as precipitation or other moisture percolates through the garbage. In this case cell perimeter leachate collection drains would probably be required to collect any liquors and these would have to be removed and treated. At present the quarry floor is mainly in a dry state, fairly even and thus in easy working condition for such construction. On the other hand the quarry is fairly small and thus the cost-benefits of such measures for potentially short life may be questionable. If this quarry is not considered for landfilling it might serve as an area for disposal of clean fill, building rubble, etc.

The Cope Quarry, site No. 17, again falls into a slightly different category than the other general sites. This quarry is also fairly dry except for minor zones as described in the appendix. The area available is again small, about the 30 acre range with quarry faces ranging from 40 to 45' on the south east maximum face to 20'± to the south west face. This quarry does not sit on the brow of the Escarpment but rather occupies the crest of a minor scarp about ½ mile south of the main one. Ground water and surface run off are to the north where there may be minor pollution hazards but this would have to be confirmed by test holes. Comments of protective measures outlined above would have to be applied here.

The sites within granular soils and landforms also potentially present problems for landfills because of the porous permeable nature of the sands. The granular soils transmit water well and hence leachate migrating from garbage also passes through them. Some purification occurs because of filtering action and dispersion although it does not attenuate chemical components

such as chlorides, sulphates etc. Sites then that have high water tables and/or surface drainage within them are often poor risks. Such areas that also use the sands for water well supplies could even be hazardous. Many of the sites selected fell into these categories. However, in the Ancaster area, the surface sands are underlain by fairly thick silts and clays that probably seal surface effects at depth. Bedrock aquifers lie far below surface, usually at depths greater than 100 feet. Two sites no. 11 and 12 appeared to be the best geotechnical situations of the sites selected although even these have some constraints for very large sites. Of the two, site 11 was of most interest because it had potentially much more area. The details of site 11 are described in the appendix but the main highlights are as follows. It would appear that cells about 15'+ deep could be dug on the property such that garbage could be placed below grade but still above the water table. Excavated materials could be used for daily cover. Eventually area fill could develop above grade but should be limited so that it would fit into the landscape. The operation would be isolated and out of view. Some zones such as a wooded ravine area and an old pit with minor water in its base should not be used. As well it would be necessary to confirm the presence of the clay seal below the sand, depth to the water table and flow both vertically and horizontally of the ground water on this site to design the facility and to obtain proper approvals.

These sites in the Ancaster area were felt to be unsuitable from a public point of view and concerns were expressed during the public participation meetings.

3.4 SITES FOR UNACCEPTABLE INERT WASTES

Many of the sites selected for study would be poor for disposal of inert wastes as well as for putrescibles and garbage. These sites are mainly those in which water occupies their bases.

The sites that appear acceptable from a hydrogeological view are shown on Map 2. Of prime consideration would be:

Site No. 3	-	part of lots 11, 12, conc. 3 Flamborough
Site No. 8	-	Canada Crushed Stone near the Escarpment
Site No. 7	-	Lot 7, conc. 4 Flamborough
Site No. 17	-	Cope Quarry

3.5 OTHER TARGET AREAS

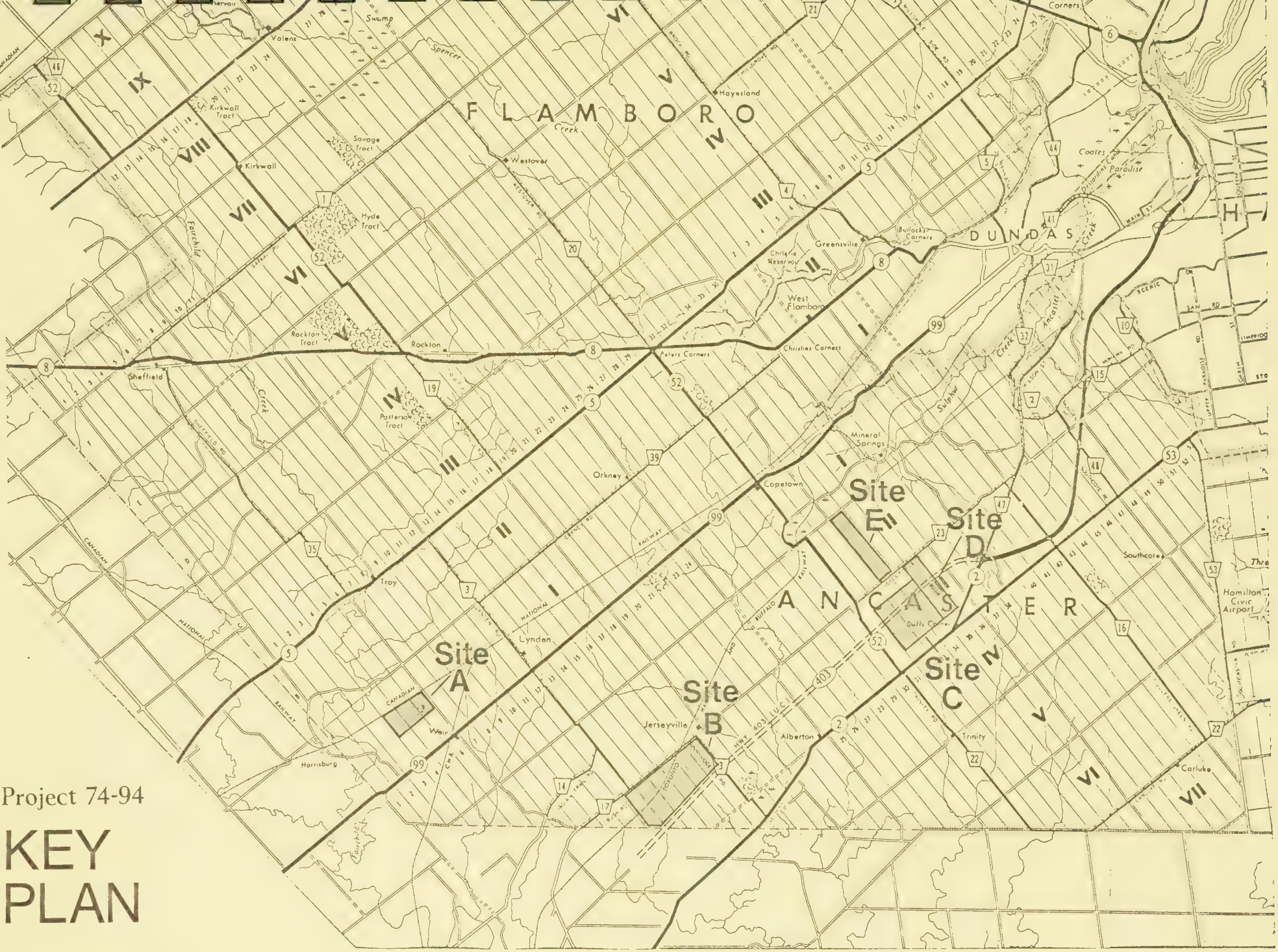
SITE A: LOTS 4 TO 6, CONC.1, TOWNSHIP OF FLAMBOROUGH

A) PHYSICAL SETTING:

From a soils point of view this property lies along the boundary of glacio-lacustrine sand and clay plain landforms mapped by Karrow of the ODM. The sandy soils form the surface of the upland plains while the clays outcrop in lower areas and along floodplains. The agricultural soil series mapped are the Grimsby series (a well drained fine to medium sand) and the Brantford series (a well drained silt and silty clay). It appears that the clays also extend underneath the sandy upland soils. Surface drainage heads just beyond this site and this has cut two ravines that trend almost east-west through the property.

Dolomite bedrock of the Guelph Lockport formation occurs between elevation 600 to 625 beneath the site. Regionally the bedrock surface which is also the water well aquifer, dips or slopes off to the south. The rock is covered by deep soils (100') of surface sands (10-20'), underlain by deep clays of very low permeability, sealing the rock at depth.

We would suspect that the surface sands have a local perched water table within them that probably forms spring lines at its contact with the clays in the valleys. The surface flows then will be from the sandy highs in the middle and northwest areas of the site toward the ravines. Surface drainage flows to the west toward Fairchild Creek. The sandy highs are local surface recharge areas. Flow in the bedrock is to the south and west, following the bedrock structure. There is a lack of hydraulic connection in the site area with the rock well aquifer at depth.



Project 74-94

KEY PLAN

Scale 1in.= 2mi.

SITE A:

B) LANDFILLING ASPECTS:

This site could probably be developed within the sandy highs as long as the waste was placed above the water table. It might be necessary to develop a perimeter leachate collection system near the sand boundaries. Development in the clays, in the ravines would be questionable due to the spring lines, high water table, surface flow, etc. Potential pollution aspects would be related to the springs along the sand/clay contact. The water well aquifer at depth appears to be isolated from the surface by the deep clays. Any problems that might develop then would be of a surface nature, related to the sands. The presence of any shallow dug wells would require investigation since the surface sands provide minimal opportunity for attenuation or purification.

SITE B : LOTS 12 TO 17, CON. 3, TOWN OF ANCASTER

A) PHYSICAL SETTING:

This property lies within the flat to gently rolling clay plain topography just south of the Jerseyville Road.

A thin veneer of fine sands of the Grimsby soil series forms a narrow ribbon along the Jerseyville Road, the northern boundary of the property. The remainder of the site is underlain by Beverly loam series complex that is developed on stratified silts and clays. Well records show that these clays extend to some depth, 130 feet ± below grade. These silts and clays then effectively seal the aquifer from surface effects.

Surface drainage flows to the south and southwest. We note that some surface flow cuts through parts of the site and of course these areas would prevent development there. Ground water flow in both the soils and the bedrock are to the southwest following surface drainage trends. Ground water recharge appears to occur to the north of the property.

B) LANDFILLING ASPECTS:

Some parts of this property would be eliminated because of potential surface drainage impacts. Cells of fairly shallow depth could probably be dug in the clays. Pollution aspects would be those related to surface water and run-off. Water well considerations do not appear to be a factor. The other problem would be one of workability in the clayey subsoils, especially in wet weather. This site is one of excellent farmland as well.

SITE C : LOTS 32 TO 36, CONC. III, ANCASTER

A) PHYSICAL SETTING:

This area occupies lands just west of the existing Ancaster landfill site. This area is flat to gently rolling in an almost corrugated effect with trends from the northeast to southwest. The subsoils here are mainly of the Grimsby-Brant series complex. Their textures are fine sands to silt. The water table is usually shallow over most of the area. Well logs indicate that lacustrine silts and clays underlie these thin surface sands. It appears that much of the drainage probably is basing itself in these clays. Local zones of organic are present. Bedrock occurs about 100 feet below grade and water flow in this aquifer is to the west.

B) LANDFILLING CONSIDERATIONS:

Impact here would be associated with surface water aspects. Extensive remedial measures probably involving stream diversion, building of base pads for the waste, leachate collection systems, etc. Deep wells would not be of concern here. Importation of cover would also probably be a consideration. This appears to be far from a suitable area.

SITE D - The Existing Ancaster Site

A) PHYSICAL SETTING:

This site was described in an earlier report of October, 1974.

This property that fronts on the Jerseyville Road at present, is an elongated parcel of land. The natural fabric of the terrain cuts across the property almost at 45 degree angles, i.e., the surface has an almost corrugated pattern in which the ravines have been cut through and across a pre-existing sand plain. The soils series here again are the Grimsby-Brant series complexes, mainly of fine sand texture. The sands here are appreciably deeper on the highs compared to property "C" to the west. Well records show lacustrine clays underlie these sands sealing the bedrock 100 feet± below. Surface drainage flows through the wooded lows and this probably bases itself on the clays. Some small ponds occur close by.

B) LANDFILLING ASPECTS:

At present this fairly small site has been developed on the edge of one of the sand highs at the margin of a ravine. Surface drainage occurs close to the fill that appears to be covered with the local sand.

As the operation extends to the south it appears that several factors would have to be considered. Surface waters will have to be protected by diversion or some method of isolating them from the waste. The waste will have to be placed in the dry, probably 5 feet± above the water table. As well, extensive cutting of bush and trees will be needed which should be assessed ecologically. Although there is no fear of deep well pollution, the surface system should probably be monitored.

SITE E : PROPOSED SITE WEST OF PADDY GREEN LANE

A) PHYSICAL SETTING:

The central part of this site is almost plateau-like with slopes off to the north and south. This landform is underlain by granular glacio-lacustrine soils, sands and gravels. The soil series on the plateau are the Springvale series, well-drained sands over outwash gravels. The lower part of the property along Jerseyville Road is underlain by Brant soils, a fine sand, the same as Sites "C" and "D". The northern part of the site along Power line road is underlain by the Ancaster series that is developed on a silty clay loam till.

Due to the soil sequence noted above and water well records on site, it appears that sands of the plateau are underlain by fairly deep sandy clay that we have interpreted as a till. This then separates the surface sands from the bedrock, located some 275 feet± below, by over 200 feet of clays.

Surface water exists at the base of the sands and appears to form springs at the foot of the plateau-like granular. Flow is to the south and west. A divide appears to prevent connection on this site with the Dundas Valley. Conversely, flow in the bedrock isolated far below is to the north toward the Valley.

B) LANDFILLING ASPECTS:

We understand that only a shallow fill is to be considered if this property were used and this would be restricted

SITE E :(LANDFILLING ASPECTS) :

to the plateau-like area.

Although we feel that the granular plateau is a local recharge area, the probability of silts and clays beneath the sand would seal any effects from migrating to depth. If leachate were formed it would probably migrate laterally in the surface sands. This could be counteracted to some extent with a leachate collection system and garbage placed in the dry above the water table. Due to the presence of some shallow wells in the surface sands down-gradient,this site will require careful detailed investigation and design. Sandy cover would be available for daily use and more impermeable final cover would have to be imported. As with all sites monitoring would be a necessary consideration.

CONCLUSIONS :

The foregoing data are based on literature search - airphoto interpretation information. Since no drilling has been done these data remain unconfirmed.

However, at this point it would appear that the sites can be generally compared from a hydrogeological point-of-view. All of the sites do not appear to have a potential impact on deep-drilled water wells. None of the sites appears to be without

CONCLUSIONS (CONT'D) :

some form of constraint. The main area of any concern is for shallow-surface waters and hence shallow wells down-gradient.

Sites "A" and "E" present similar types of settings and hence possible types of considerations. At this point site "E" probably has more useable area and might be more easily controlled and engineered hydrologically.

Site "B" in the clay plain is also of minimal impact. However, with the loss of area due to surface drainage, shallow trenching due to the water table and difficult wet weather operation, it should be grouped third hydrogeologically.

It appears then that the existing site should follow next. Here the wooded ravines and water courses provide constraint for further expansion. Site "C", the low wet area to the west is probably unsuitable and would require extensive remedial measures.

It should be remembered that the above grading is based on a hydrogeological opinion alone. These should be compared with other non-geological factors and it should be remembered that these data at this point are unconfirmed at depth.

CHAPTER 4 - THE PROPOSED GLANBROOK BALEFILL SITE

4.1 INTRODUCTION

The location of this proposed site is shown on Map 3. Further more intensive study has been carried out for this target area and the environs surrounding it. At this point no subsurface drilling has been carried out due the planning nature of the study. As well details within the property remain unverified due to the inaccessibility onto private lands. If this site is to be considered further a subsurface geological programme will be required and this is detailed in Chapter 5 that follows.

4.2 THE EXISTING PHYSICAL SETTING

The regional unit, the deep clay plain over bedrock, is shown on Map 1, and this site is typical for this unit except for the adjacent floodplain.

Details of the surface soils are shown on Map 2 and it indicates that the subsoils are silty clays. Well logs in the area show that these cohesive soils extend to depths probably in the range of 45 to 50'± over the bedrock. We would suspect that detailed borings will probably show till soils at depth below the silt and clay surface soils. Agricultural mapping indicates soil series of the Binbrook silt loam (imperfectly drained silt loam over clay till) and the Smithville

series (moderately well drained) occupy most of the site. The exceptions to this are the floodplains that cut through the site. In general, slopes are flat to undulating except along the well confined valley walls. Agriculturally these lands unfortunately are those of ARDA class 1 & 2 as shown on Map 4.

The area is shown in cross section on drawings 5 and 6 appended. The bedrock beneath the area of the site is the prime water well aquifer, generally 45 to 50' below surface but apparently sealed by the underlying soils. As shown on the north-south cross section sands and gravels occur at depth in the Binbrook area. Recharge to the aquifer in the site area appears to be to the north.

4.3 HYDROGEOLOGICAL SETTING

The potentiometric contours of the bedrock water well aquifer show that flow in the rock appears to be from north to south across the site as one would expect and follows a trend similar to the surface of the top of the bedrock. Discharge in the rock appears to be to the south and east of the site.

The groundwater table in the soils will probably follow a slightly different pattern. This upper system will tend to be a subdued replica of the ground surface and we would suspect that flow will be toward the rivers of the area. The groundwater table will

fluctuate but we would expect depths to the saturated zone to be in the order of 10 to 15' on the highs. In dry periods the upper soil surface probably tends to dessicate. It would appear then that with fairly low gradients and probable soil permeabilities in the 10^{-7} cm/sec. range that groundwater flow would be very slow.

4.4 LANDFILL ASPECTS SETTING

From a pollution potential point of view groundwater aquifers would be well protected from any form of leachate that might be produced from landfilling. Ground water flow in the clayey soils would be extremely slow and the clay contents of such soils provides high attenuation potential via ion exchange. Any leachate effects would be those of a near surface and/or run off nature. Standard provisions should be able to deal with these. As noted earlier the areas of flood plain and a boundary beyond these would be unavailable for landfilling. As long as the waste was placed above the water table, leachate would be produced only from infiltration and/or standing water. Placement of the bales would probably take place at first within shallow trenches and then proceed above grade using the excavated material as cover. These soils will probably require stockpiling so that wet and cold weather operations are not hampered unduly. As well proper road access will be required. Gas should not be a problem if venting, a standard procedure, is used.

In summary then, the site appears to have minimal pollution hazards at depth. Problems if they are present will be those of a surface nature and operational. These can be overcome with proper engineering and working practices. These lands will be taken from agriculture however, rehabilitation might be towards this end. As well, detailed subsurface studies, on site, will be needed to confirm these aspects and these are outlined in the section that follows.

CHAPTER 5 - FUTURE DETAILED STUDY

5.1 INTRODUCTION

In order to establish a sanitary landfill site in Ontario, various multi-disciplinary studies and types of investigations are required by the Province. The results of these studies are reviewed and assessed by the Ministry of the Environment. In accordance with the Environmental Protection Act the applicant must then submit his case to the Environmental Review Board in a public hearing. If the case is successful then a certificate is presented by the Ministry and the facility can be put into operation.

One of the studies required by the Provincial Authorities is a detailed hydrogeological investigation of the proposed site and its environs.

5.2 SCOPE & OBJECTIVES

A detailed hydrogeological investigation will involve the drilling of boreholes and monitoring wells to assess the geological (soils and bedrock), hydrological (surface and ground water), setting of the area. The study is intended to establish the details of the present setting in three dimensions, assess its suitability and/or constraints for landfilling, and to provide guidelines to assist in the design and operation of the facility.

The hydrogeological study should have the following objectives:

(1) To provide the required information for the Ministry of the Environment to assess the site's suitability and any constraints for landfilling from a hydrogeological point of view.

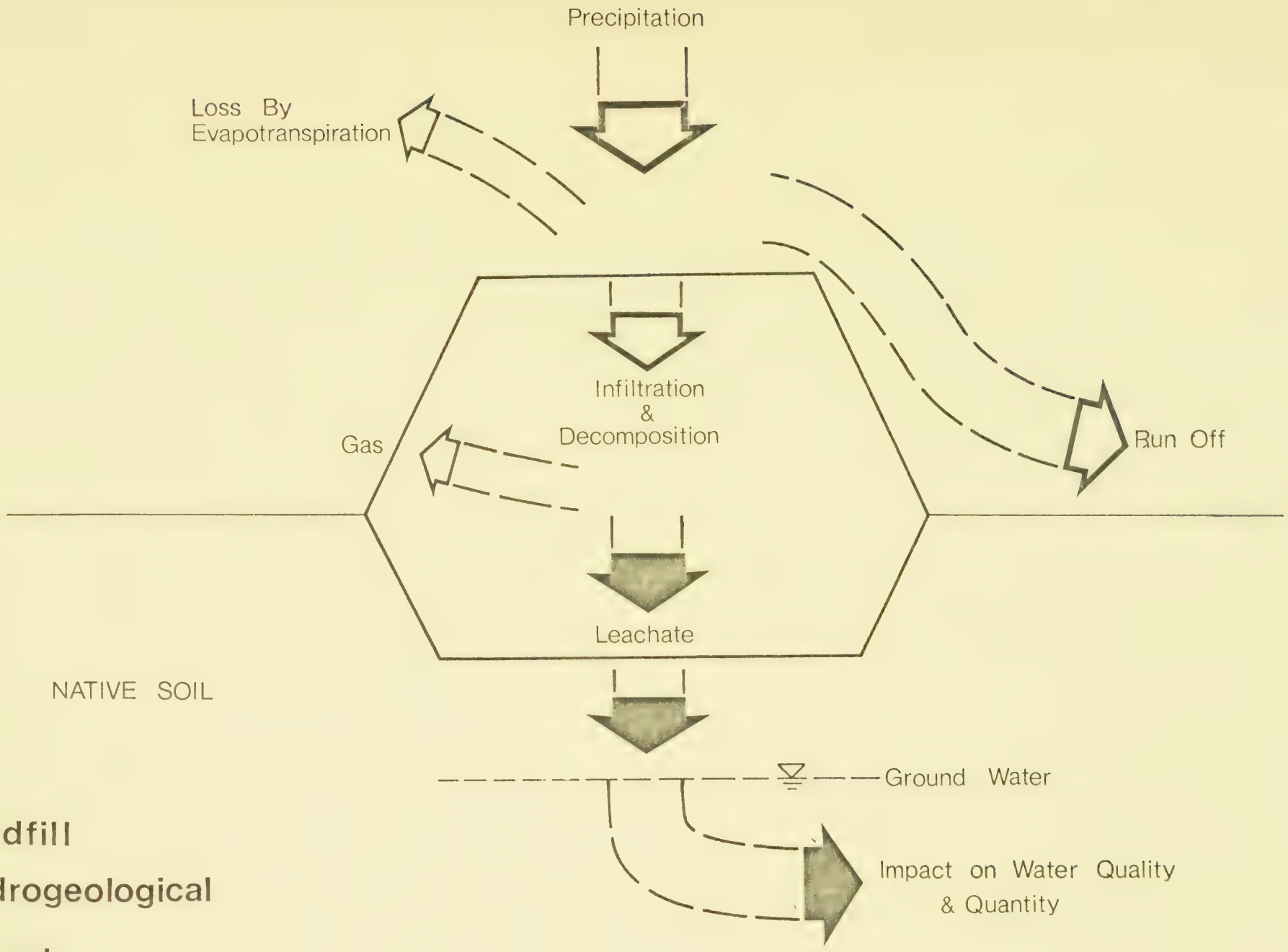
(2) To provide a basis for the Environmental Review Board on which it can found part of its decision.

(3) To provide hydrogeological details that are required by the Consultants for their overall design of the site and operational aspects.

(4) To provide the framework for an environmental quality monitoring network (ground and surface water quality).

In summary then, the study should provide a 3-dimensional picture of the lands as they now exist, assess the physical suitability of the site for landfilling and outline any constraints that might exist, as well as providing guidelines for design and operation.

Figure 4 shows the various aspects that will require examination. In effect a water budget exists in the area now. The study should then be used to predict any impact expected in the system due to imposing a landfill within it. These data will be used to in effect confirm or deny its suitability, assist proper design, monitoring etc. as well as predict the probable impact.



Landfill

Hydrogeological

Impact

FIGURE 4

The hydrogeological study of a regional scale landfill site based on our past experience and dialogue with the Ministry of the Environment, will probably have to deal with the following factors.

1. The geology of the site and its relationship to the surrounding area

   - soils; textures, depths, stratigraphy (geometry), permeability, leachate attenuation potential, compaction characteristics, etc.

   - bedrock; type, geometry, permeability.

2. The hydrology of the site and its relationship to the surrounding area

   (a) <u>ground water</u>:

   - position of the ground water table, its fluctuations and geometry
   - the ground water flow system i.e. direction of flow both horizontally and vertically, the velocities, etc.
   - relationships of the site to water well aquifers and existing wells in the area. The degree of hydraulic connection will also have to be assessed.
   - the water budget i.e. infiltration, evapotranspiration
   - relationship of the site to the regional flow system i.e. recharge and discharge.

(b) surface water:

- run off patterns, spring seepage, etc.

3. Suitability of the Site, its pollution potential and possible impact on the setting.

4. Design Guidelines and Recommendations

- probable cell (excavation) depths
- cover suitability
- drainage measures, methane gas aspects
- ground water monitoring recommendations

5.3 RECOMMENDED APPROACH

We would recommend carrying out the study in stages. These stages or phases would assist the one that followed by providing it with base data, and allow us to confirm the impressions of its suitability etc., as the project progressed. If severe constraints or unexpected developments were discovered, then these could be discussed at that point rather than waiting for completion. In order to carry out this type of study we have assumed permitted access onto the lands. Without such accessibility it would be impossible to carry out the suggested study. As well, our proposal assumes the availability of topographic contour coverage of the site.

The first step in carrying out the study would be to map the surface soils, drainage, seepage and slopes of the sites. The relationships of the sites to the Welland River and associated creeks would be most critical. As well we would anticipate locating

local water wells on the site and its environs. Where possible static levels in the wells would be measured to assist in our ground water table evaluation. The details of this first stage would assist us in finalizing the borehole locations.

The second stage would involve the drilling of test holes. For this site we would envisage using a hollow stem auger drilling rig. We have found in our past experience that this can most efficiently be done with 4¼" inside diameter augers. In this way the holes do not have to be cased or the drill stem disturbed in order to obtain soil samples, core any rock, or install ground water monitoring pipe. In the holes, samples of the soils would be obtained with a split spoon sampler and logged by the supervising engineering geologist. We envisage most of the holes being taken to bedrock, the water well aquifer, some 40± to 50± feet below surface. It will be necessary to diamond drill the rock to investigate its quality as well. We envisage installing PVC pipe within the holes to monitor the ground water systems in both the rock and the soil. These monitors would involve two types of installations, piezometers and standpipes. The standpipes would be placed 10'± below the soil water table and these would be used to obtain data to contour it. This set of monitors would be placed in the early stages. The second set of monitors would be in the form of piezometers, to provide water pressures at depth. These would be used to predict the vertical directions of ground water flow in the soil and flows in the bedrock.

These ground water monitors would be left in place to measure changes in the water table in the long term, especially in the spring, to obtain design data (e.g. the elevation of the base of the fill). These installations would also be available for determining the ground water quality, now i.e. before solid waste placement, and they would be available for later observations during the operation.

During the drilling, the permeability of the rock would be determined by 'down the hole' tests. The soil samples and rock core would be returned to the laboratory for tests on selected representative samples.

Cross sections of the site would be developed showing the geological geometry and ground water details. As the project progresses we envisage a continuing liaison with the MOE representative to discuss the findings of the study. At this time we feel that the drilling program will involve 40 to 50 sites.

At the conclusion of the study the Consultant would issue an engineering report that would deal with:

(a) the existing physical setting of the site
- geology
- soils
- drainage
- ground water, etc.

(b) the suitability of the site for solid waste disposal, the pollution potential and probable impact

(c) recommendations for design, monitoring of the site, constraints, etc.

This report then would provide the data for:

(a) The Environmental Review Board Hearings

(b) Assisting the design of the site and provide guidelines from a soils point of view for its operation

(c) Long-term monitoring of the quality of the physical environment.

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APPENDICES

APPENDIX

DESCRIPTIONS OF INDIVIDUAL SELECTED SITES #1 TO 21

SITE NO. 1 LOT 7, CON 9, E. FLAMBOROUGH (25 ACRES)
OWNED BY TIBBITS BULLDOZING.

Geologically this site occupies a worked out sand and gravel pit that excavated an esker (granular ridge) landform. Subsoils within the site are sands and gravels with the bedrock surface probably not far from present grade. These permeable subsoils provide excellent infiltration for precipitation. It would appear ground water flow is toward the creek nearby and no doubt good connection exists between this site and these surface waters. Availability of proper cover is also a question.

The Balaclava school is adjacent to the site.

This site then appears unsuitable from a hydrogeological point of view due to its potential adverse impact on this area. The permeable sandy subsoils with good hydraulic connection and the possibility of bedrock nearby would negate the use of this site for garbage disposal, in our opinion.

SITE NO. 2 LOT 3, CON 8, E. FLAMBOROUGH TWP. (20 ACRES)
OWNED BY CLOVERDALE SAND & GRAVEL.

This 20 acre site is a sand and gravel pit that lies adjacent to the ravine of Bronte Creek and one of its small branches. The creek has cut down through the sands and gravels of an outwash deposit of glacial age. The pit has been excavated into this sand and gravel plateau near its boundaries with the ravines. This granular plateau is surrounded laterally by glacial till subsoils. The granular then is a local recharge source for the Bronte Creek.

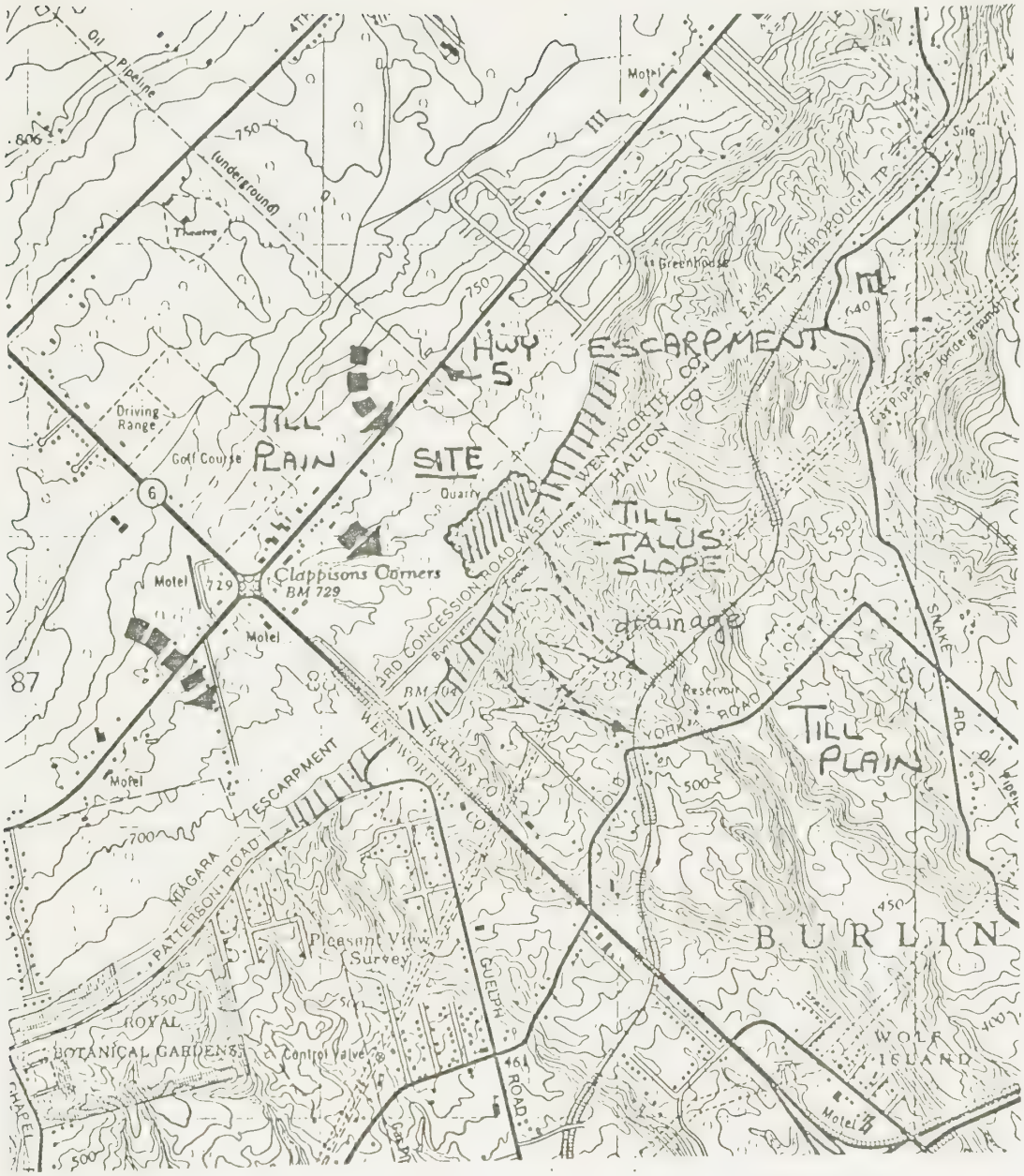
Lands to the south and west of the site may be more suitable for disposal purposes. It would appear that the areas back from the Creek would probably be underlain by glacial till and hence possibly sealed at depth. Other factors such as access and impact or other land use tend to negate even these zones for disposal purposes.

SITE NO. 3 ABANDONED QUARRY
OWNED BY S. J. SHEPPARD
PART OF LOTS 11, 12, CONC 3, E. FLAMBOROUGH.

This quarry lies 1000' ± southeast of the intersection of Highways 5 & 6, near the Clappison's Cut. Although this quarry is at present unacceptable for solid waste disposal it may be possible to engineer an operation in this setting. These measures, however, will no doubt be costly and time consuming. On the other hand it is isolated and hidden from view.

The quarry has been excavated into the face of the Niagara Escarpment and the Guelph Lockport dolomite bedrock has been excavated to 25'±. In the surrounding area, thin silt tills have been smeared over the rock and these are generally less than 10' deep. Wells and topography show a migration of ground water flow towards the escarpment mainly within the dolomite caprock (an estimated gradient of about 4% moves to the south towards the quarry). Spring seepage emanates from the base of the quarry face near its northwest edge and a surface drain carries this out and over the face of the Escarpment. The south side of the quarry abuts on the till-talus slope of the Escarpment and this is treed. Air-photos show springs emanate near the base of the slope. The base of the Escarpment and the lands below are underlain by the fairly impermeable red Queenston shale. The 1972 photos show the nearest houses down gradient are on the till-shale plain ½± mile to the south.

Although this quarry is presently not suitable for landfilling it may be possible to place a seal with subdrains on its floor. By installing a leachate collection system garbage might be safely placed by in effect cocooning it. If cost-benefits should show such measures to be impractical then this quarry might be used for disposal of construction debris and clean fills.



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probable ground water flow

surface drainage

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SITE NO. 3

SITE NO. 4 ALDERSHOT EQUIPMENT RENTAL LANDS
LOT 8, CON 8, WEST FLAMBOROUGH TWP.
70 ACRES±

This site lies within Kame moraine topography, as mapped by Karrow in the Ontario Department of Mines survey of the area. A till drumlin forms the south boundary of the property. The central part of the property is occupied by man made ponds that appear to be fed and drained by existing surface streams. The northern half of the property is underlain by shallow surface sands and stony sandy glacial till or hardpan. The water table probably occurs at shallow depth under this site. Some shallow soil borrow pits are found in the north portion of the lands and these were probably dug in connection with Highway 6 reconstruction. Bedrock appears to underlie the site at 20 to 30' below grade and slopes off to the south and east.

It would appear that less than half of these lands might be considered for disposal purposes, those to the north. Even here the suitability is questionable with the water table probably within a few feet of grade and with surface waters so closely associated. A number of water wells are also present down gradient from the site, mainly concentrated at the Village of Strabane.

In summary, these lands should probably not be considered for disposal purposes. These lands could be used for placement of clean fill material especially where borrow fills have been excavated.

SITE NO. 5 LANDS OF JON-BEN ENTERPRISES, (100 ACRES) LOT 8, CON 7, WEST FLAMBOROUGH TWP.

These lands occur within a flat sand and gravel (glacial outwash) plain. These sands and gravels appear to overlie the bedrock which ledges off to the south between 10 and 20 feet from surface. The past owners have excavated the sands and gravels to below water table and a surface pond occupies the bottom of the pit. As well a small surface stream runs from north to south through the site. Ground water flow is then also towards the south via these sands and gravels, towards a major swamp to the south where it probably discharges. A recreation area, that also uses a pond in the base of another gravel pit, lies next to this property on its south side. A direct hydraulic connection between the proposed land and this recreation complex probably exists.

Therefore these granular lands have a high pollution potential for solid waste disposal. As a result this property should not be considered for disposal purposes of any kind.

SITE NO. 6 GUELPH SAND AND GRAVEL PROPERTY (50 AC) LOT 7, CONC 6, WEST FLAMBOROUGH

This property is intimately connected to the physical setting of site no. 5, discussed earlier. A shallow gravel pit occupies the northern half and water table is within 1 to 2 feet of grade here. The remainder of the property is wooded with granular soils that also appear wet.

For the same reasons as property 5, this site should not be considered for solid waste disposal.

SITE NO. 7 FLAMBORO QUARRIES (30 ACRES)
LOT 7, CON 4, WEST FLAMBOROUGH

This shallow quarry has been excavated into the Guelph Lockport dolomite to produce about a 20' face. Soils are generally less than 5 feet over the rock. From well logs it appears that this area is a bedrock topographic high and thus acts as a recharge zone for ground water in the bedrock. Static water levels in wells indicate flow away from this area toward wells down gradient.

As a result since the dolomite is the principal ground water aquifer for wells and the quarry is in a recharge position we would recommend that this quarry not be considered for disposal purposes.

SITE NO. 8 — CANADA CUT & CRUSHED STONE
QUARRY OPERATIONS IN CON 2 & 3, LOTS 9-11
AND CON 1, LOTS 13-15, WEST FLAMBOROUGH TWP.
(400 ACRES ±)

These are extremely large and actively operating quarries above the Escarpment just to the north of Dundas. The major operation straddles Highway No. 5. Ground water is handled by a sump system in the base of the quarry south of the Highway. The area around the quarry appears to be the source for surface drainage. Water well records also show that the quarry area has a ground water mound beneath it. This mound coincides with a high in the bedrock where soil cover is also thin. This quarry is located within a ground water recharge zone so that placement of wastes here could produce a hazard for wells close by and down gradient. Further this Lockport dolomite is highly jointed so that water is transmitted easily as would be leachate if it entered this system.

We feel that these quarries are in a delicate ground water setting and as such should not be used for the placement of solid waste.

SITE NO. 9 MILLGROVE SOD SUPPLY PROPERTY
LOTS 10 & 11, CONC 5, WEST FLAMBOROUGH TWP.
70 ACRES±

This sod and peat mining operation occupies a flat low wet area where much of the subsurface is saturated organics. The water table is near surface at all seasons of the year. Small surface ponds occupy the property and surface drainage takes place to the south via a series of minor creeks. The northern portion of the property is heavily wooded. Subsoils in the area are shallow sands veneering glacial tills. Bedrock probably comes to within 5 feet of surface on the west side of the site. Ground water probably discharges in this area to feed the surface systems.

We would not recommend this site for solid waste disposal because of the high water table, organic subsoils etc. and surface drainage situation. There would be no cover available on site and filling would have to be above grade on fill pads etc. to isolate it from the waters, probably with leachate collection facilities.

SITE NO. 10 ABANDONED BORROW & QUARRY OPERATIONS
LOT 18, CON 4, BEVERLY TWP.
20 ACRES.

This small site is located within 1500 feet of the Village of Sheffield in Beverly Township and is occupied by a small sand and gravel as well as former rock quarry operation. The soils are shallow sands and gravels flanked by sandy tills. The bedrock structure in this area controls the topography and the soil cover is in the order of 2 to 5 feet deep locally. As with many quarries this site is underlain by a topographic high in the rock. Ground water also appears to mound here and flows outwards in almost all directions but most important towards the village. The base of the quarry had water standing within it during the site visit.

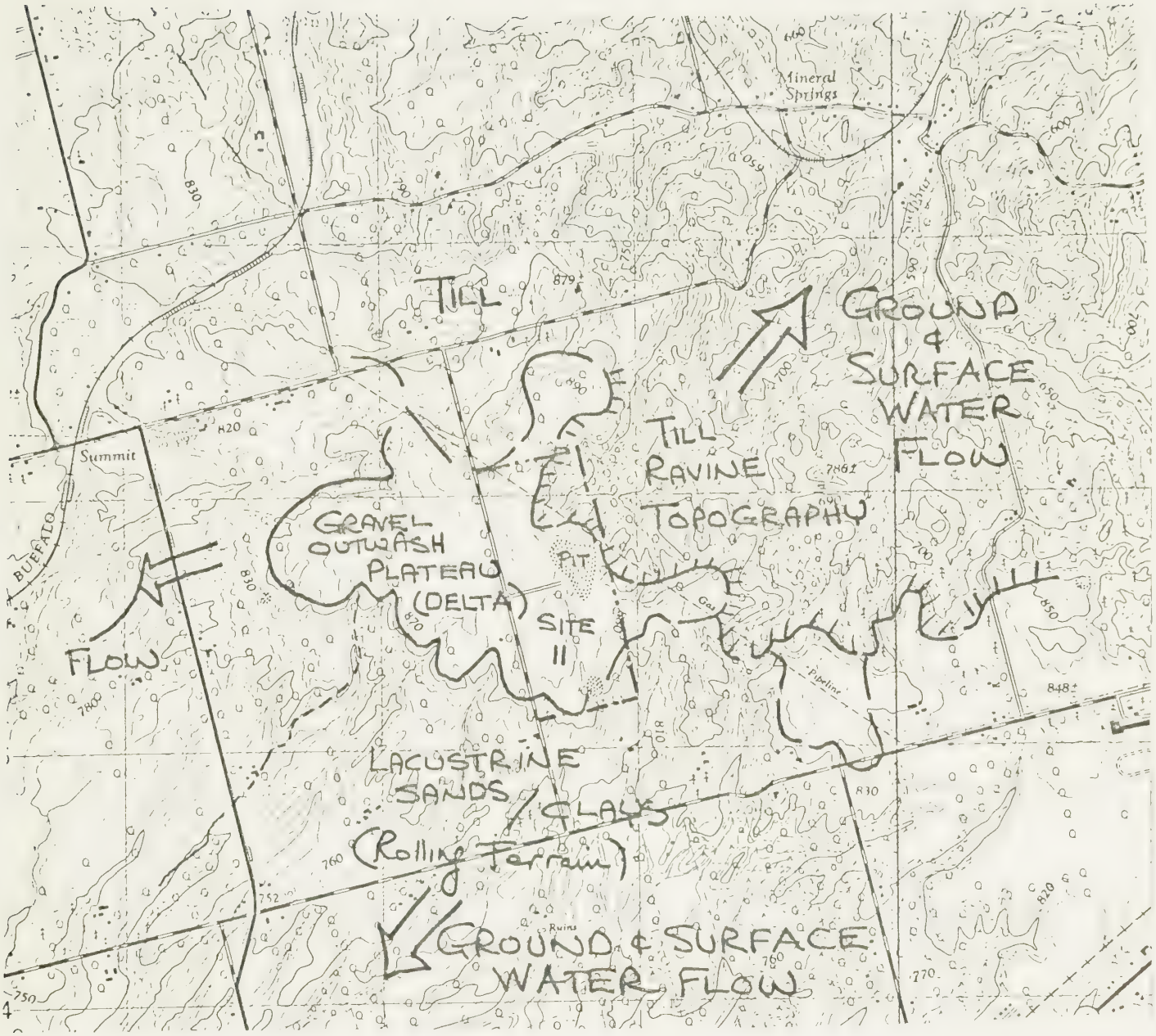
This small site would have a high hazard potential if leachate where produced and migrated from this site. Its small size, lack of cover and adverse hydrogeologic environment would rule out this site for disposal of waste of any kind.

SITE NO. 11 J. GREENE PROPERTY
LOT 34, CON 2, ANCASTER TOWNSHIP.

This property is located 1000' north of the Jerseyville Road near Paddy Greens lane. These lands lie within glacial lacustrine granular outwash soils. Well logs in the area show that these sands are underlain at depth by clays and silty clays that would tend to seal off effluent migration to depth. The dolomite bedrock aquifer lies between 150 to 200 feet below surface. The site straddles the surface water divide in the area and deeply dissected ravine topography occurs to the north and east of the site. An old gravel pit has been dug into the sands in the central part of the property. We would expect that the water table probably lies somewhere in the 15 to 20' range below surface of the flat plateau like landform.

Although we would suspect that ground water recharge occurs in this area, the probability of silts and clays below the surface sands probably effectively seals the system at depth. In assessing this site for approvals and design it would be necessary to drill holes into the clays at depth to prove this seal. As well both vertical and horizontal components of ground water flow would have to be measured and no doubt monitored. A cell method of disposal may be viable here with later area fills above surface. Sandy cover would be available for daily cover and final more impermeable cover would have to be imported. Some surface drainage appears to head on and near the property, probably where the surface sands have been eroded down to the clays below them. Fills should be kept away from these areas unless special engineering and construction is carried out first.

In summary then this property appears to be worth further consideration from a hydrogeological point of view. If other factors also appear favourable we would recommend that this property be assessed in detail to investigate this potential site.



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SITE NO. 11

SITE NO. 12 SMITH HAULAGE PROPERTY
LOT 36, CON 2, ANCASTER TWP.

This property lies close to site No. 11, Major amounts of sands have been extracted from this site. The physical setting then is similar to site 11 but it lies downslope from No. 11 and hence the sands are probably shallower over the clays. The northern half of the lands is more dissected and surface drainage passes through it. The property borders on the Jerseyville Road so that it is more visible than No. 11.

As a result of the above this property appears much less desirable than No. 11 for use as a solid waste disposal site. This site could be used for placement of clean fills and building rubble to rehabilitate the sand pit area.

SITE NO. 13 MTC SAND & GRAVEL PIT (20 ACRES)
LOT 45, CON 3
ANCASTER TWP.

SITE NO. 14 O & J INVEST. PROPERTY (35 ACRES)
LOT 45, CON 3, ANCASTER TWP.

These two properties are separated by the Hwy. 403 corridor and have been exploited for sand and gravel. Geologically they lie within granular glacial outwash land forms with sand and gravel subsoils. The dolomite bedrock is probably in the 75 to 100 foot range below surface and well records shows that clays and tills seal the surface sands from the rock below. The 1972 airphotos revealed water in the base of the worked out gravel pits. Surface drainage passes through property 14 on the south side of Hwy. 403 and skirts the west boundary of property 13 on its way to the north. The surface sands in which the pits have been dug appear to be shallow. The drainage then has eroded down to the clays below these sands and the channels are now based in them.

Both sites lie adjacent to urban development and probably access would have to be via such roads rather than directly from Hwy. 403. These non geological aspects are also of importance in rating these sites.

Geologically these sites could probably be rated as borderline with surface water pollution aspects as most critical. Although these sites should probably not be considered for garbage, rehabilitation with clean fills might be possible.

SITE NO. 15

A. PHINN PROPERTY
LOTS 41, 42, CON 4,
ANCASTER TWP. (40 ACRES)

This site is also associated with the granular glacial outwash landform. Sands and gravels on the property have been mined in two pits. Surface drainage on the site has been dammed up to form an elongated pond. As well the photos show surface springs on the site that are the heads of surface drainage. Therefore much of the property is low and wet with this surface water being fed from the sandy highs.

We would recommend that this site not be considered for placement of waste of any kind due to its high pollution potential.

SITE NO. 16

S. MILES PROPERTY
LOT 14, CON 1,
GLANFORD TWP.

This 25 acre property is traversed by several small drainage courses that flow to the north and east towards the Escarpment. Subsoils are silty clays and tills but it would appear that the soils are shallow and probably only a veneer over the rock in some areas. A pond is based in an abandoned quarry. Photo patterns suggest that rock ledges in the area in an almost east-west line. Spring seepage lines may be associated with this pattern.

As a result of the abundance of surface drainage, seepage and shallow rock we would recommend this site not be used for disposal of solid waste.

SITE NO. 17 A. COPE AND SONS QUARRIES
LOTS 25, 28, CON 6, SALTFLEET TWP.

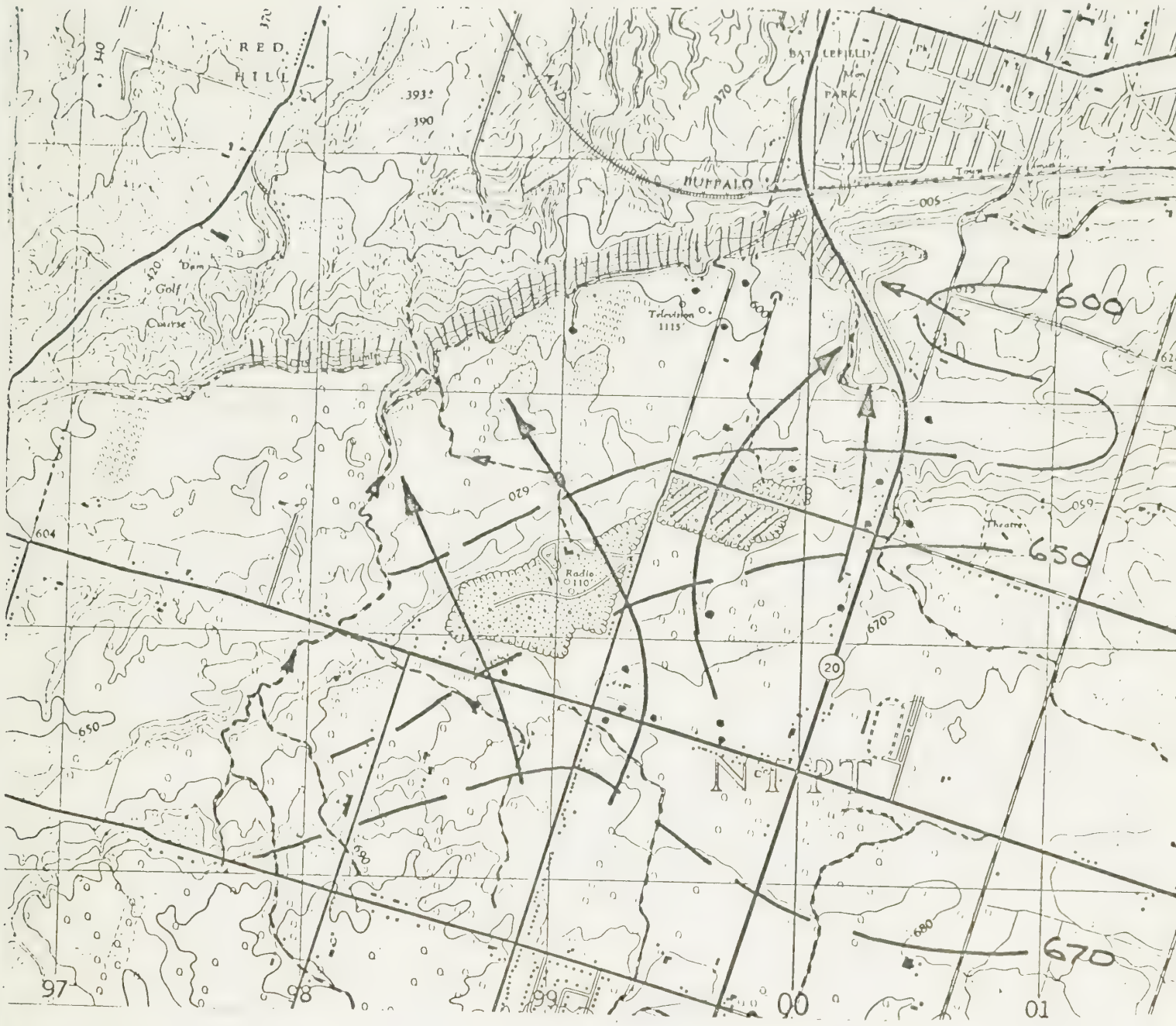
Two quarry zones have been developed between Mud Street and Green Mountain Road. Both works have been excavated down into the Guelph formation dolomite bedrock. The northern margins of the quarry floors co-incide with a minor bedrock scarp that occurs ½ mile ± south of the Niagara Escarpment. The Niagara Falls moraine, a ridge of deeper till lies just to the south of the property but lands around the quarries have less than 10 feet of soil cover. Ground water flow in the bedrock is to the north over the mini scarp, migrating to small streams both east and west of the site. It would appear then that bedrock wells would not be of major concern because of these flow directions but this would have to be confirmed. Surface water flows from the quarry via shallow drains cut in the bedrock floor. The southwest quarry is fairly shallow (12-20'±) and appears much wetter. As well a housing project is to be developed just to the south, across Mud Street. This zone is being actually used in the plant operation. As a result this southwest quarry is probably not of interest for disposal aspects.

The northeast quarry zone is presently not in active use, at least at the time of this survey. The pit itself is fairly small, about 30 acres. The maximum face is in the range of 45' but most of the area falls in the 25'± category. The quarry is drained with gravity sumps that feed to its north-west corner. The dolomite floor is fairly flat with minor waste piles. Blasting has opened some joints oriented parallel to the scarp face.

This quarry is presently unsuitable for placement of solid waste. In our opinion it would be necessary to carry out fairly extensive construction before landfilling could be suitably achieved. This would require first of all confirming the ground water flow both vertically and laterally both in

and beyond the site. If the permeability of the rock is not too high it may be possible to seal this surface and provide subdrains for the natural flow. In effect it would be necessary to cocoon the garbage as with site no. 3. A leachate collection system would also be required.

In our opinion it may be a more useful function to use this quarry for disposal of clean fills and construction materials. However, because of its location and cost benefits it may be viable to landfill but it should be remembered that this will require very careful design, construction and ongoing rigid control of the operation.



HYDROLOGICAL SETTING

surface drainage

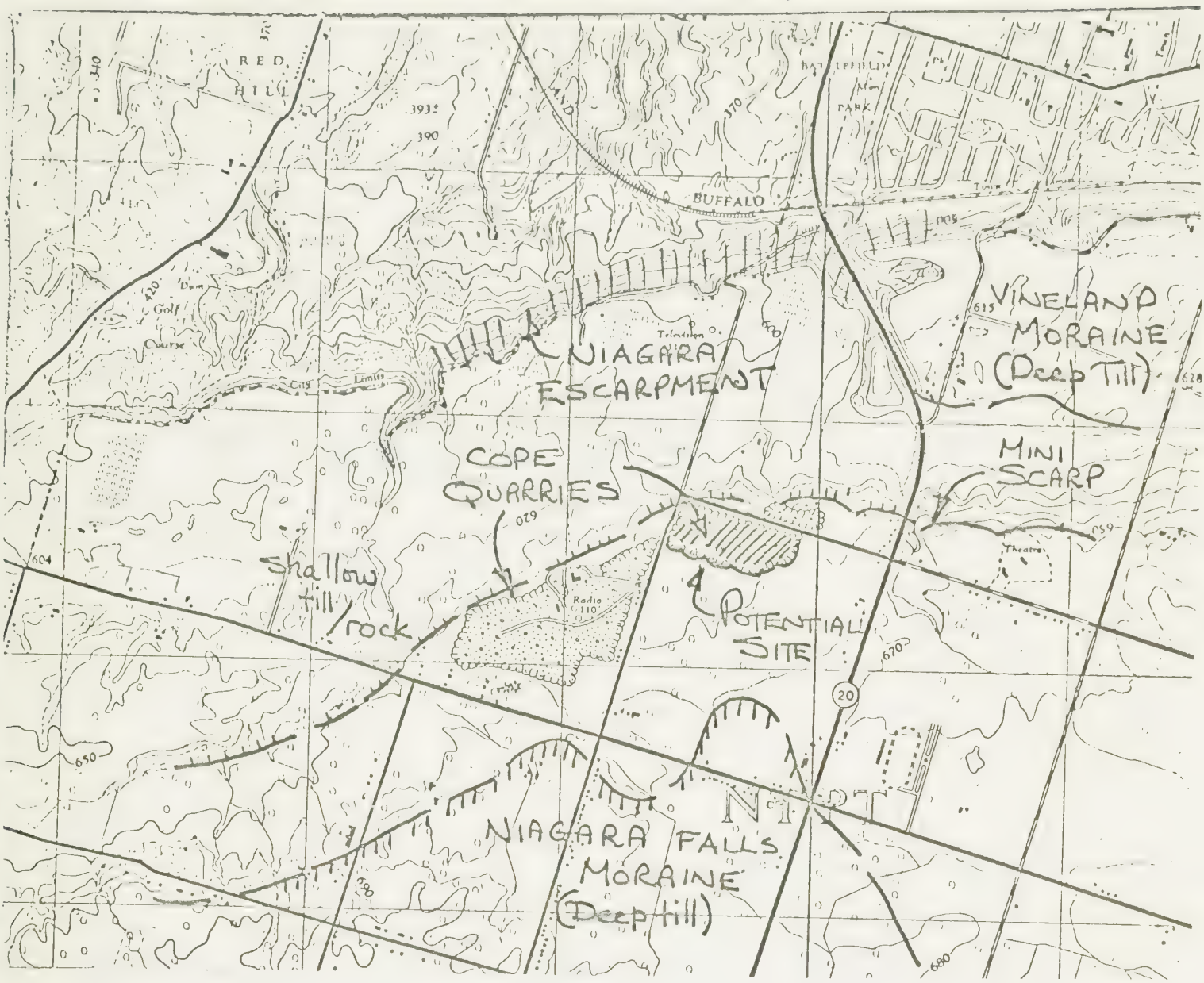
ground water potentiometric contour in bedrock

flow direction

N

Gartner Lee Associates Limited

SITE No. 17



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GEOLOGICAL SETTING

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Gartner Lee Associates Limited

SITE No. 17

SITE 18 — ARMSTRONG BROTHERS QUARRY
LOT 5, CON 5, SALTFLEET TWP.

SITE 19 — TWP QUARRY,
LOT 4, CON 4, SALTFLEET TWP.

These two quarries adjoin each other and are situated at the intersection of Green Mountain Road and 10th Road East in Saltfleet Township, due south of Winona. The Armstrong Brothers quarry is still active. Both quarries are situated on the crest of a minor scarp in the bedrock and both are water filled. It appears that the present operation in Site 18 requires pumping. On property 19 two small lakes that occupy the quarry bottom also feed surface drainage that flows to the north. Ground water flow is in the same direction. The bedrock is the main water well aquifer.

Both quarries in our opinion have a high pollution potential and as such should not be considered for waste disposal of any kind.

SITE NO. 20 LOT 8-9, CON 8, WEST FLAMBOROUGH (90 ACRES)
OWNED BY COX CONSTRUCTION LIMITED.

This site adjoins property No. 6 discussed earlier. Its eastern boundary is Hwy. 6. Shallow sand and gravel pits have been dug into kame granular and sandy till. The ground surface is gently undulating and the presence of water in one of the shallow pits indicates that the water table is probably close to grade. The southern part of the property is treed and appears to be wet. Bedrock may be at very shallow depths as well, possibly less than 10'±.

As with property 4 much of this land appears to be unuseable for solid waste disposal due to high water table conditions and shallow bedrock. The property is fully exposed to Hwy. 6 throughout its length.

SITE NO. 21 D. SMITH PROPERTY (60 AC)
LOT 43, CON 5, ANCASTER TWP.

This site adjoins Fiddler's Green Road just north of Book Road in Ancaster Township. A sand and gravel pit has been excavated into a ridge that cuts across the south end of the property. This ridge was formed as a beach in glacial age times. The lands are underlain then by sands and gravels, local zones of which appear to be 'cemented' into rock like strata. Several zones of spring seepage were mapped around margins of the site. Water is impounded behind a dam on the property just to the north and it appears that some flow takes place toward this pond. Water well logs indicate that silts and clays lie at depth in this area so that much of the flow probably takes place laterally. Therefore pollution of the shallow system and surface waters nearby would be a possibility if solid waste was implaced here.

We would recommend that this site not be considered as a waste disposal site due to the potential pollution hazard.

SITE NO. 22 PART LOTS 11, 12, CON 9, EAST FLAMBOROUGH
84 ACRES.

This property is located on flat to gently undulating glacial outwash sand and gravel lands adjacent to Bronte Creek. The exception to this topography is an elongated oval shaped hill of sand and gravel into which two pits have been excavated. The ground water table appears to be close to grade over most of the property and subsurface flow probably takes place to the north towards Bronte Creek where it discharges. A fringe of the land along its south border appears to drain towards a swampy low just across the road from the property. Water wells indicate bedrock occurs at depths in the 20 to 30 foot range.

It would appear that these granular lands are intimately associated with Bronte Creek that cuts across this property. As well the neighbouring lands to the east have been developed as a tourist trailer park that features ponds that have been created by dams across the same Bronte Creek. As a result we would recommend that these lands not be considered for any type of waste disposal.

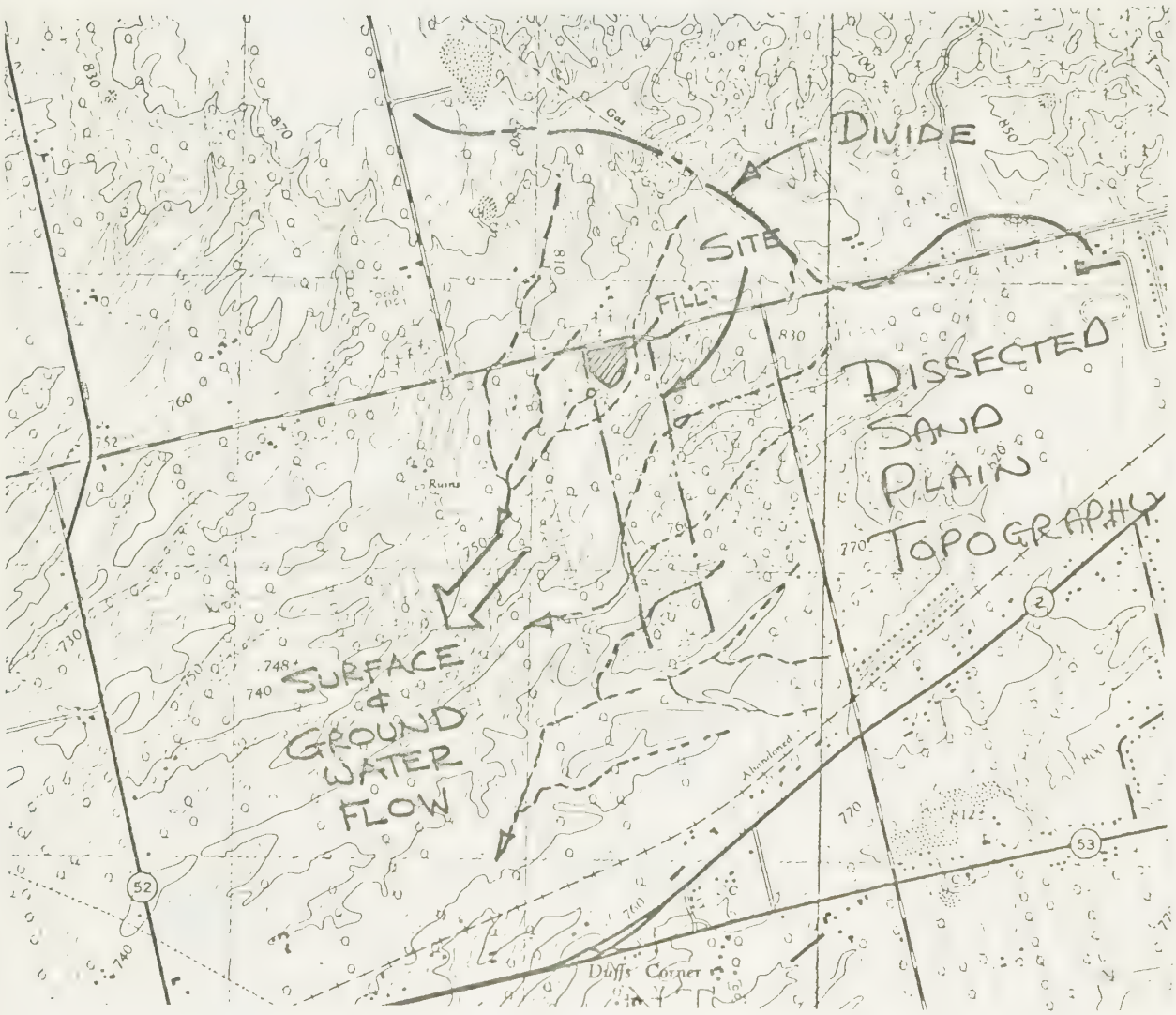
EXISTING ANCASTER LANDFILL SITE

This property that fronts on the Jerseyville Road is a narrow elongated parcel of land. The natural fabric of the terrain cuts across the property almost at 45^{o} angles, i.e. the surface is almost a corrugated pattern in which ravines have been cut through and across a pre existing sand plain. The drawing that follows shows the minor ravines that cut northwest-southeast through the site. The surface soils are stratified fine sands that were deposited in glacial lake waters. Well records show that stratified silts and clays were deposited in the same environment before these sands and thus underlay them at depth. Surface drainage now flows in the base of these ravines and it would appear that locally these surface flows have cut down through the sands and may be basing themselves on the clays below. Small ponds are common in the area and two of these occur near the margins of the property.

The existing fill has been placed on the edge of one of these minor ravines and slopes off to the south from elevation 820± and sits about 30 feet above the surrounding terrain. A small creek flows around the perimeter of this fill and a small pond sits near its margin at elevation 785±. Water in this pond probably represents the regional water table at the base of these sands. Cover material is the native sand.

As this operation expands to the south the operation will have to deal with these surface waters. It will be necessary to ensure that these surface flows are not impeded and certainly not allowed to contact solid waste. In fact it will be necessary to ensure that the waste is placed in sand in the dry, preferably not lower than 5 feet above the high water table conditions. As well as the surface water problem it will be necessary to do some cutting of trees and bush on the property.

We would further recommend that some form of monitoring be carried out on this site. Although there is no fear of deep seated pollution for wells at depth there should be a check on the shallow system within the sands, especially as the operation expands. A proper site preparation and development plan should be established to ensure that the impact of the site is a minimum.



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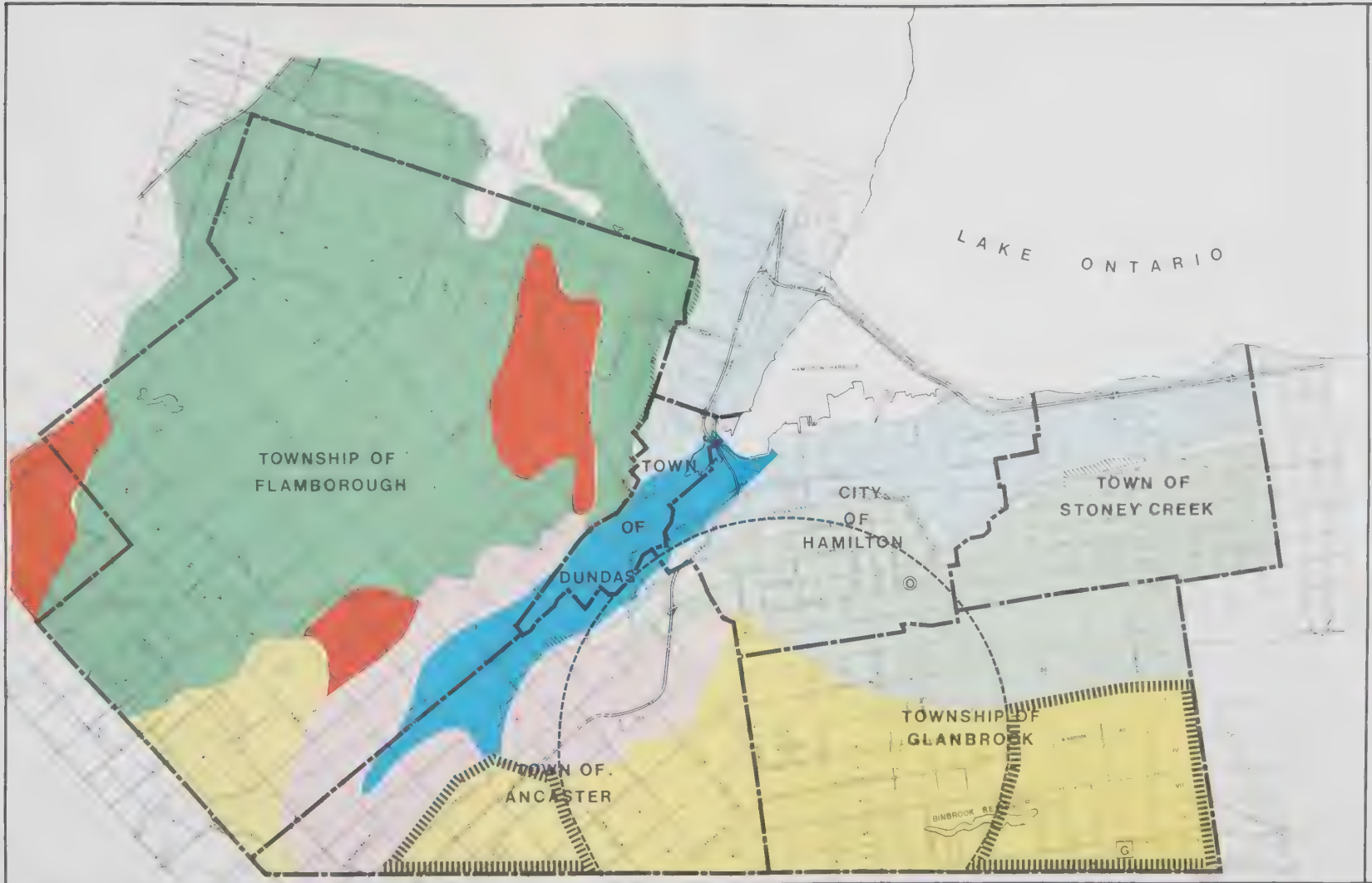
EXISTING
ANCASTER
LANDFILL
SITE



Hydrogeological Conditions

Legend

SUITABILITY FOR SANITARY LANDFILL SITES

Most Suitable

'Reducing Suitability'

Least Suitable

6 MI. RADIUS FROM MOUNT HOPE AIRPORT

AREAS MOST APPROPRIATE FOR MAJOR SANITARY LANDFILL SITES

SOLID WASTE DISPOSAL FACILITY

◎ Existing Upper Ottawa Street Landfill Site

G Proposed Glanbrook Balefill Site

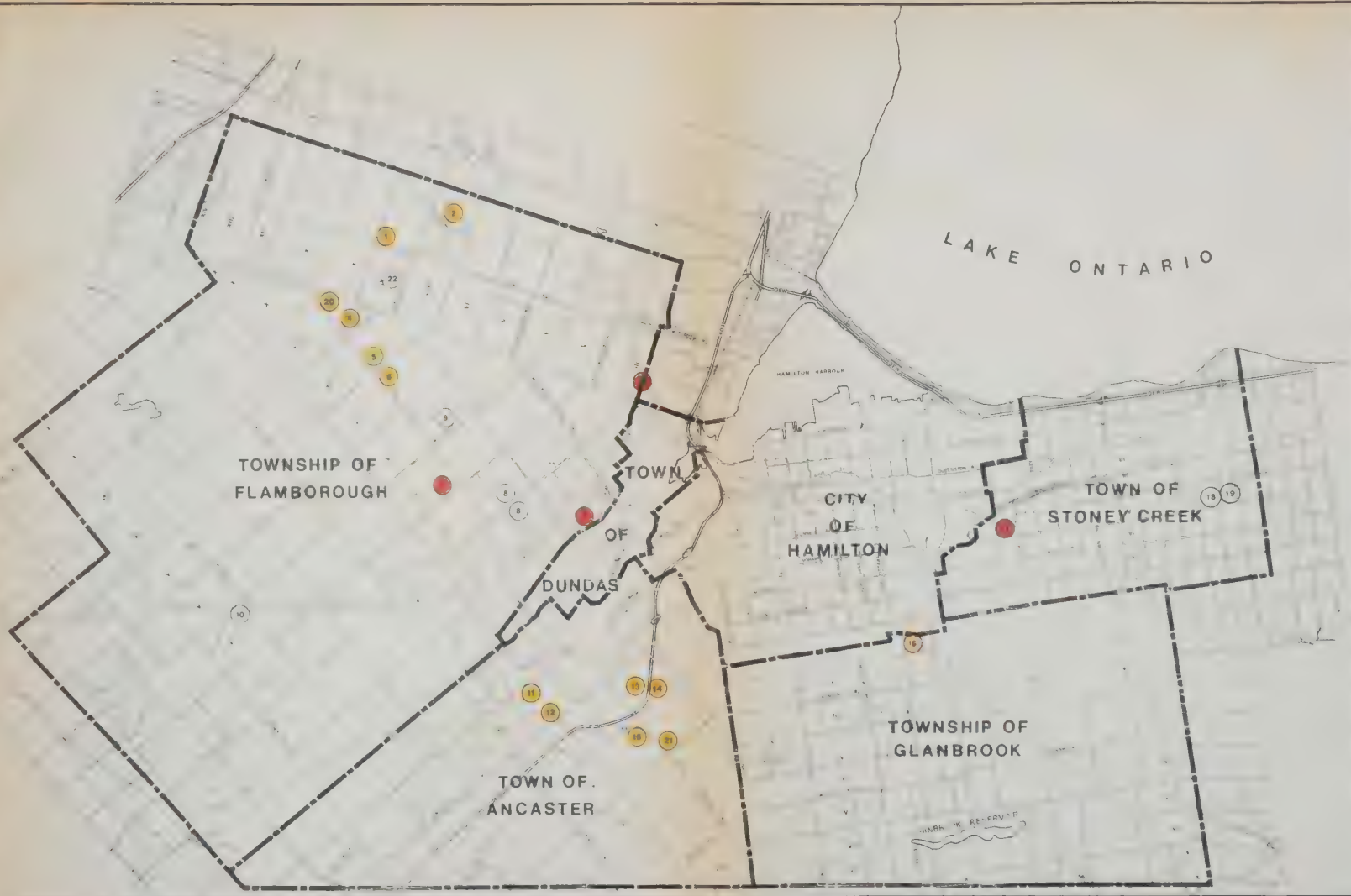
Gartner Lee Associates Limited

Hamilton-Wentworth Waste Management Study

Proctor & Redfern Limited
Consulting Engineers and Planners

Scale in Miles
1 ½ 0 1

Dwg No. 1



Quarries & pits in the Region that may be used as disposal Sites for non-acceptable Wastes

Legend

- (14) Existing Quarry
- Existing Gravel Pits
- Prime Sites For Inert Wastes

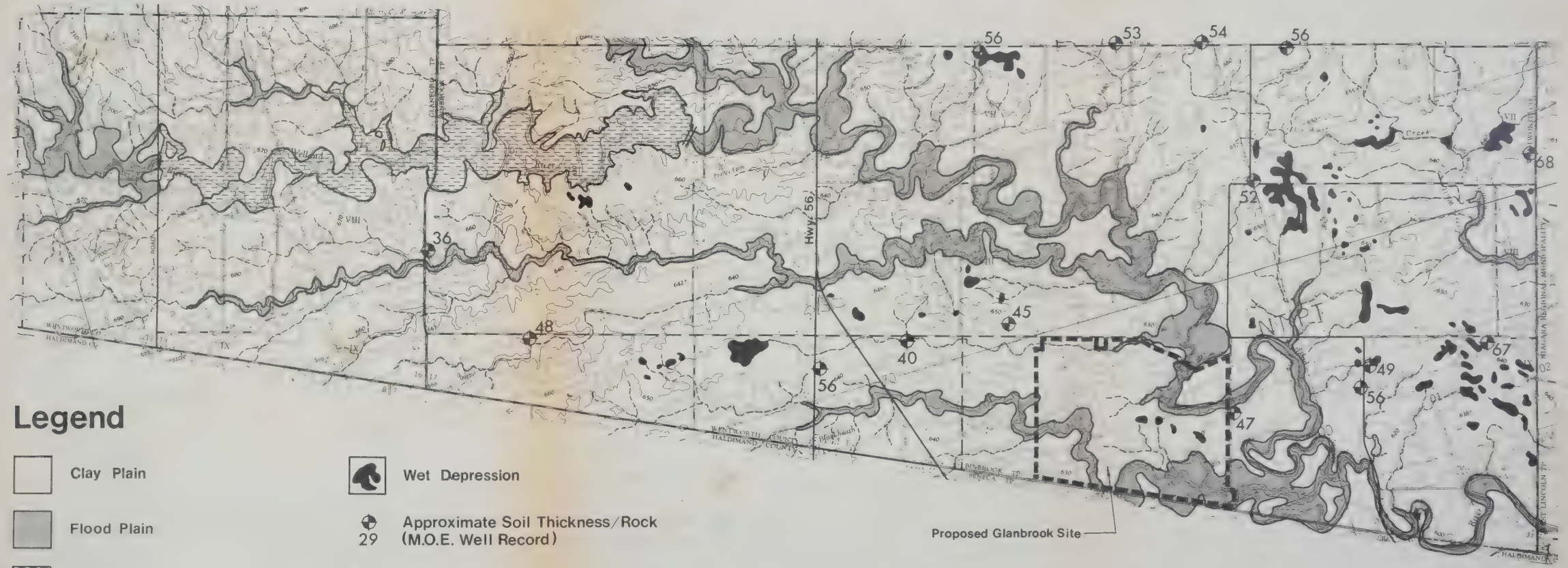
Hamilton-Wentworth Waste Management Study

Proctor & Redfern Limited
Consulting Engineers and Planners

Scale in Miles
1 ½ 0 1

Dwg. No. 2
Jan. 1975

Terrain Features - Glanbrook Site



Legend

- Clay Plain
- Flood Plain
- Lake
- Wet Depression
- Approximate Soil Thickness/Rock (M.O.E. Well Record) — 29
- Intermittent Stream

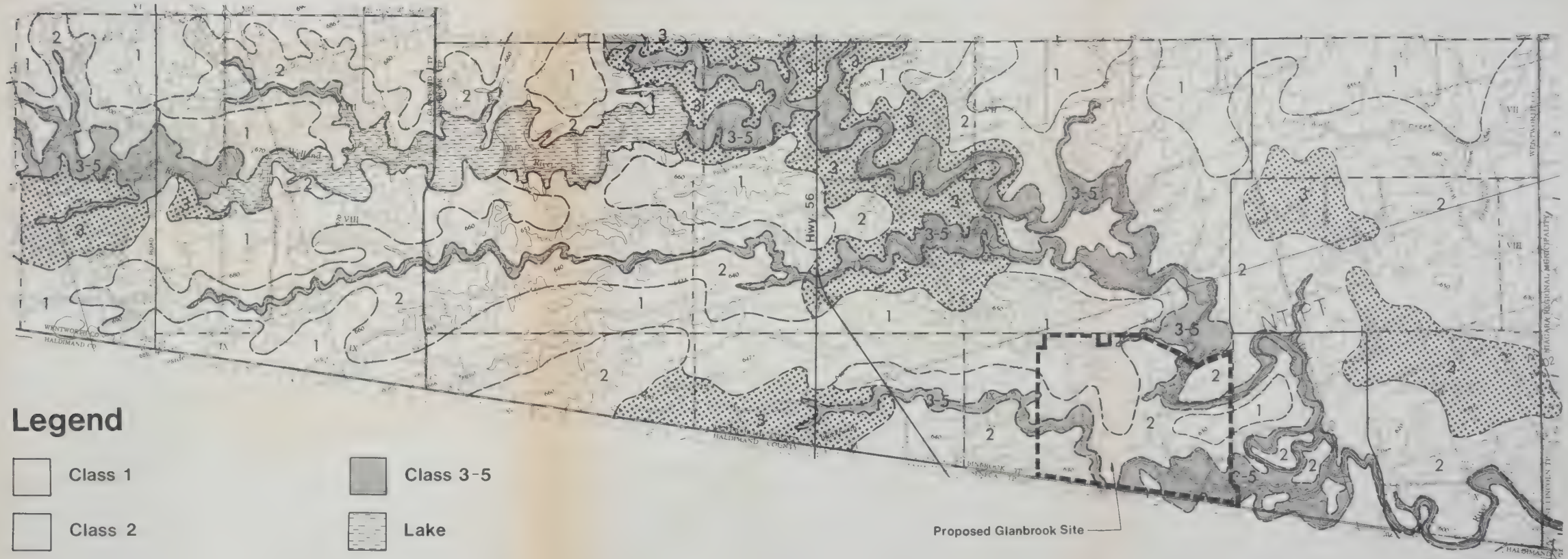
Hamilton-Wentworth Waste Management Study

Scale 1:25,000

Map 3

Gartner Lee Associates Limited

Soil Capability - Glanbrook Site



Legend

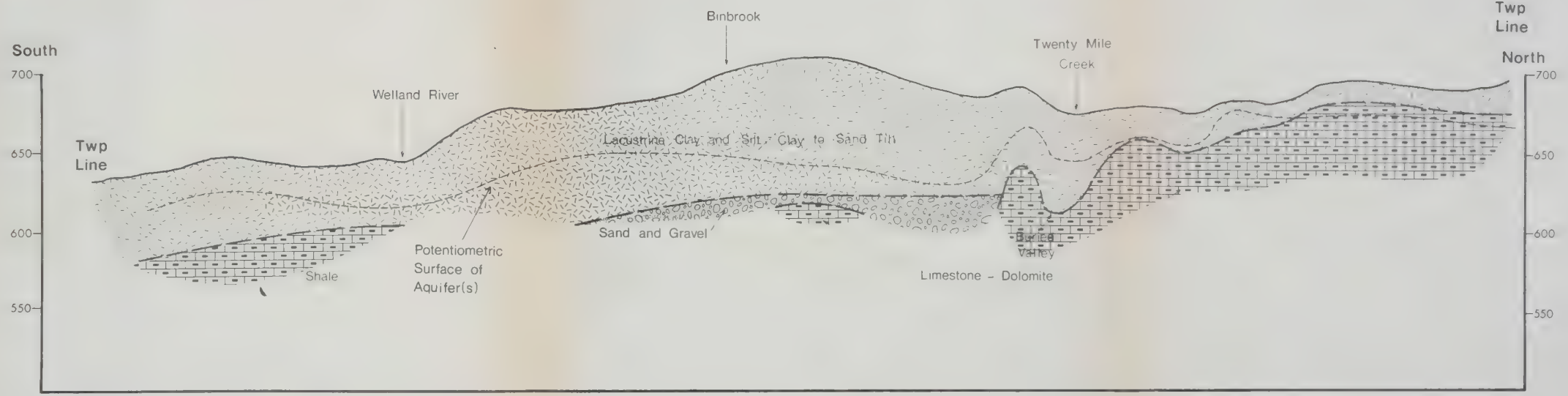
- Class 1
- Class 2
- Class 3
- Class 3-5
- Lake

Hamilton-Wentworth Waste Management Study

Scale 1:25,000

Map 4

Gartner Lee Associates Limited



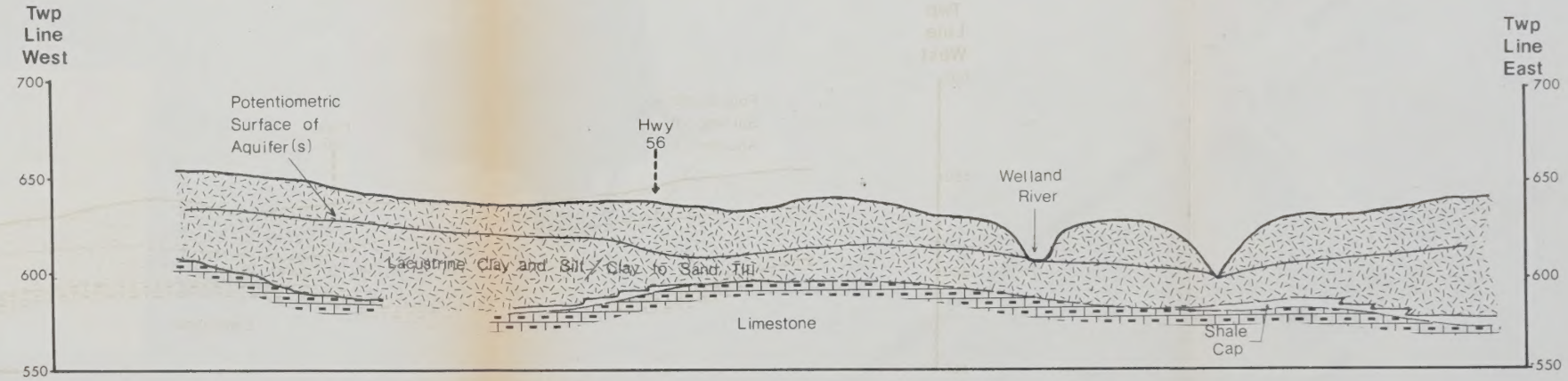
North-South Cross Section
Glanbrook Township

Along Hwy 56

Scales: Horizontal 1" = 2,083'
Vertical 1" = 50

Gartner Lee Associates Limited

Hamilton-Wentworth Waste Management Study **Map 5**



Cross Section Along South Boundary
Glanbrook Township

Scales: Horizontal 1" = 2083'
Vertical 1" = 50'

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